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(54) **Mold separation method and apparatus**

Verfahren und Vorrichtung zur Trennung von Giessformen

Procédé et dispositif pour la séparation des moules

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(73) Proprietor: **Johnson & Johnson Vision Care, Inc.**
Jacksonville, FL 32216 (US)

(72) Inventors:
- **Kindt-Larsen, Ture**
  DK-2840 Holte (DK)
- **Beaton, Stephen Robert**
  Neptune Beach, Florida 32266 (US)
- **Martin, Wallace Anthony**
  Orange Park, Florida 32065 (US)
- **Pegram, Stephen Craig**
  South Jacksonville, Florida 32223 (US)
- **Walker, Craig William**
  Jacksonville, Florida 32224 (US)

(74) Representative: **Mercer, Christopher Paul et al**
Carpmaels & Ransford
43, Bloomsbury Square
London WC1A 2RA (GB)

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- **PATENT ABSTRACTS OF JAPAN vol. 014, no. 122 (P-1017), 7 March 1990 & JP-A-01 316702 (MITSUBISHI RAYON CO LTD), 21 December 1989,**
- **PATENT ABSTRACTS OF JAPAN vol. 006, no. 249 (M-177), 8 December 1982 & JP-A-57 146629 (HITACHI SEISAKUSHO KK), 10 September 1982,**

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D scription

1. Field of the Invention

[0001] This invention relates generally to the production of ophthalmic lenses, and, in particular to a method and a device for removing molded soft contact lenses, high-precision intraocular lenses, and the like, from the individual molds in which they are produced.

2. Description of the Prior Art

[0002] As the ophthalmic contact lens industry has grown, it has become desirable to supply contact lenses that are periodically and frequently replaced to minimize the possibility of user induced contamination. This has produced an opportunity for manufacturers to strive for automated methods and apparatuses that are able to automatically produce high quality ophthalmic lenses in a cost-effective and highly efficient manner.

[0003] It is current practice in the art of making ophthalmic lenses, such as soft contact lenses of the hydrogel type, to form a monomer or monomer mixture that may be polymerized in a plastic molu. Details of typical direct mold processes for forming soft hydrogel contact lenses can be found in U.S. patents 5,080,839, 5,039,459, 4,889,664, and 4,495,313. The process for forming soft contact lenses as generally described in the above-mentioned patents includes the steps of dissolving a monomer mixture in a non-aqueous, water-displaceable solvent and placing the monomer/solvent mixture in a mold having the shape of the final desired hydrogel lens. Next, the monomer/solvent mixture is subjected to conditions whereby the monomer(s) polymerize, to thereby produce a polymer/solvent mixture in the shape of the final desired hydrogel lens. After the polymerization is complete, the solvent is displaced with water to produce a hydrated lens whose final size and shape are similar to the shape of the original molded polymer/solvent article.

[0004] Examples of typical plastic molds used for carrying the polymerizable feed material are disclosed in U.S. Patent Nos. 5,094,609, 4,565,348 and 4,640,489. The mold disclosed in U.S. Patent 4,640,489 is a two-piece mold with a female mold portion having a generally concave lens surface, and a male mold portion having a generally convex lens surface, both mold portions preferably made of a thermoplastic material such as polystyrene. As discussed in U. S. Patent 4,640,489, polystyrene and copolymers thereof is a preferred mold material because it does not crystallize during cooling from the melt, and exhibits little or no shrinkage when subject to the processing conditions required during the direct molding process discussed above. Alternatively, molds made of polypropylene or polyethylene, such as described in U.S. Patent No. 4,121,896, may be used.

[0005] During the molding process, the monomer and monomer mixture is supplied in excess to the female concave mold portion prior to the mating of the molds. After the mold portions are placed together, defining the lens and forming a lens edge, the excess monomer or monomer mixture is expelled from the mold cavity and rests on or between flanges that surround one or both mold portions. Upon polymerization this excess material forms an annular (HEMA) ring around the formed lens between the flange portions of the molds.

[0006] As discussed in the above-mentioned U.S. Patent Nos. 5,039,459, 4,889,664, and 4,565,348, there is the requirement that the materials, chemistry, and processes be controlled so that the mold portions may be separated without having to apply an undue force, which may be necessary when the lens sticks to one or more of the lens mold or when the lens mold portions are adhered to each other by the excess HEMA ring after polymerization.

[0007] The prior art process for separating the mold portions and removing the lens therefrom consists of a heating stage, a prying open of the mold portions, and a lens removal stage. The heating stage of the prior art lens removal process is to apply heat by convection to the back mold portion by applying a heated air stream to the mold. The differential expansion between the heated mold polymer and the cooler lens polymer shifts one surface with respect to the other. A side pry bar is jammed between the molds from one side, and the back curve mold is pried to pivot the back curve mold upwardly from one side. The prying force then breaks the polymerized lens/polymer mold adhesion and separates the mold portions.

[0008] When mold parts formed with an integral frame, such as that illustrated in U.S. Patent No. 4,649,489, are separated the frame limits access to the space between front and back curve mold halves. Further, even minimal warpage of the integral frame can adversely affect both the access to the space and the accuracy of the side pry forces.

[0009] Further, when access is limited, the side pry mechanism must be driven between the mold halves, which also affects the accuracy of the side pry forces.

[0010] The greater the temperature gradient between the mold halves and the lens, the less an adhesion force will exist between the lens and the mold halves and less force will be required to separate the mold portions. This effect is greatest when there is a maximum thermal gradient. Lower thermal gradients created between the mold halves and the lens will require a greater force to separate the mold portions resulting in increased possibility of fracturing a mold portion. Newer techniques for achieving a temperature gradient between the back lens mold and the contact lens

include laser demolding techniques as described in European patent application EP0588660 and contemporaneously filed case VTN-75 (see item 3 on the attached concordance).

[0011] EP0588660 discloses an apparatus and method for removing a molded ophthalmic lens from between the mold portions in which it is produced. A source of intense electromagnetic radiation, preferably a carbon dioxide laser of about 80 Watts at a wavelength of 10.6 μm, is applied to at least one of the mold portions. The exposure of the mold portion to the laser is between one half and one second. Differential expansion of the heated mold polymer relative to the cooler polymer shifts one surface with respect to the other, and the shear force breaks the polymerised lens / polymer mold adhesion and assists in the separation of mold portions. The greater the temperature gradient between the surfaces of the mold portions, the greater the shearing force and the easier the mold portions separate. The heated back mold portion is promptly removed so that very little energy is transferred to the polymer lens, avoiding the possibility of thermal decomposition of the lens.

[0012] Further techniques for achieving a temperature gradient between the back lens mold and the contact lens include steam impingement as hereinafter described in detail below.

[0013] The lens mold portions, containing the polymerised contact lens therein, may be pried apart by mechanical leverage which may be provided manually. A test fixture used to measure the forces required to open the molds is described in above-mentioned U.S. Patent No. 4,889,664, which discloses a holding fixture for holding the bottom half of the lens mold and a lever means positionable between the top mold half and bottom mold half for prying the top half away from the bottom half at a controlled rate.

SUMMARY OF THE INVENTION

[0014] It is an object of the present invention to provide a method and apparatus that can easily and repeatably separate the contact lens mold portions having a contact lens formed therebetween with out damaging the lens.

[0015] It is another object of the present invention to provide an automated means to mechanically and reliably pry the mold halves apart in a consistent and reliable manner to thereby enhance the production of defect free lenses, and minimize the tearing of the lens or the breakage of the lens mold parts.

[0016] It is a further object of the present invention to provide a method and apparatus for separating a back curve mold from a front curve mold wherein the back curve mold is of a different temperature relative to a contact lens contained in a cavity formed between the two mold portions.

[0017] It is yet another object of the present invention to provide a method and apparatus for separating a back curve lens mold from a front curve lens mold wherein the back curves are removed and placed in a remotely located receptacle after separation.

[0018] It is another object of the invention to perform such separation without excessive environmental heating or waste of energy.

[0019] Another object of the instant invention is to reduce contact lens manufacture process time by applying steam heat to a contact lens mold assembly to create a thermal gradient between back curve and front curve lens mold portions thereof in a fast and efficient manner prior to mold separation.

[0020] These and other objects are attained by an apparatus for separating a back mold half from a front mold half of a contact lens mold assembly useful in the production of a contact lens, each of the front and back mold halves having a central curved section defining a concave surface, a convex surface, and a circular circumferential edge, at least part of at least one of the concave surface and the convex surface having the dimensions of the front or back curve, respectively, of a contact lens to be produced in the mold assembly. The apparatus further comprises a means for applying steam to the concave surface of the back mold half while maintaining the convex surface of the front mold half at a first temperature to form a temperature gradient between the convex surface of the back mold half and the contact lens, wherein the temperature gradient ranges from about 2.5°C to 6.0°C; and, a prying means for insertion between the circumferential edges of each the front mold and back mold halves of the contact lens mold assembly, the prying means including a first set of pry fingers for biasing the back mold half at a predetermined force with respect to the front mold half to effectively remove the back mold half therefrom.

[0021] Further benefits and advantages of the invention will become apparent from a consideration of the following detailed description given with reference to the accompanying drawings, which specify and show preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

Figure 1 is a general top plan view of the mold separation apparatus of the instant invention illustrating steam nozzle mounting assemblies, the steam head retraction assemblies, the suction cup assemblies, and two lens

mold pallet conveyors carrying pallets thereon.

Figure 2 is a front view of two lens molds situated in respective cavities of the lens mold pallet.

Figure 3 is a diagrammatic side view showing generally the two sets of pry fingers lifting the back curve lens mold from the front curve lens mold.

Figure 4(a) is a front elevational view of the steam demolding assembly illustrating the steam demolding assembly on one side and the suction cap assembly on the other side, both in a raised position, prior to engagement with the lens molds.

Figure 4(b) is a front elevational view of the steam demolding assembly with a steam demolding assembly on one side shown in its lowered position to discharge steam to the back curve lens mold surface, and a suction cup assembly on the other side to remove the mold parts from the pry fingers.

Figure 5 is a detailed cross-sectional view of the nozzle for discharging steam against the back curve lens mold surface.

Figures 6(a) - 6(d) illustrate in detail the sequence of steps for separating the back curve mold portions from the front curve mold portions of a plurality of contact lens molds in a first embodiment of the mold separation apparatus; wherein

Figure 6(a) illustrates the device with the steam nozzles engaging the mold parts and the pry fingers engaging the mold flanges;

Figure 6(b) illustrates the retraction of the steam nozzles, and engagement of the suction cup assembly;

Figure 6(c) illustrates the upward pry motion of the assembly to remove the back curve mold part from the front curve mold and molded lens;

Figure 6(d) illustrates the retraction of the pry fingers to allow removal of the back curve mold parts by the suction assembly, and advancement of the pallet containing the partially demolded lenses.

Figure 7 illustrates the suction cup assembly 90 of the present invention.

Figure 8(a) illustrates a front view of the suction cup assembly 90 taken along line 8'-8' of Figure 7.

Figure 8(b) illustrates a side elevational view of the suction cup assembly 90 taken along line 8"-8" of Figure 7.

Figure 9 is a partial plan view of the demolding assembly illustrating two sets of pry fingers for each of the pallets conveyed on conveyor 13 and conveyor 14.

Figure 10 is a top view showing pallet 21 having eight (8) contact lens molds situated therein.

Figure 11 is a detailed elevational side view of' the steam discharging apparatus.

Figure 12(a) is a top plan view of the steam discharge manifold for distributing steam to each of the nozzle assemblies of steam discharging apparatus.

Figure 12(b) is a top plan view of the condensate manifold for venting excess steam pressure during steam impingement to regulate the amount of steam discharged to the back curve lens mold surface.

Figure 12(c) is a top plan view of the cover assembly of the steam discharge apparatus showing piping for housing heater cartridges.

Figure 13 is a detailed cross-sectional view of the steam intake valve of the steam discharge apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] The ophthalmic lens to be demolded in the practice of the present invention is preferably formed in a cavity defined by contact lens mold portions formed by the processes discussed in the U.S. patents mentioned in co-pending contemporaneously filed case VTN-79 (see item 7 on the attached Concordance).

[0024] Figure 1 generally illustrates, in plan view, the mold separation apparatus 10 of the instant invention that generally comprises two essentially identical steam discharge apparatuses 65a,65b in addition to respective associated demolding assemblies 100a,100b, shown as phantom lines in the Figure, for accomplishing the simultaneous demolding two parallel lines of a plurality of contact lens molds each containing an ophthalmic lens therein. The use of two parallel lines increases the throughput of the production line. Each of the conveyors 13, 14 carry a series of pallets, generally illustrated at 21, which provide support and registration for a plurality of contact lens molds carried therein.

[0025] As illustrated in Figure 1, pallets 21 containing the contact lens molds are conveyed along pallet conveyors 13,14 in the direction indicated by the arrows A. Each of the pallets 21 are positioned at respective steam discharge apparatuses 65a,65b and may be timed to arrive at the demolding assemblies 100a,b at the same time, or, may be timed to arrive in an alternative manner.

[0026] Each pallet conveyor 13,14 enables transport of a pallet 21 (shown generally in Figure 2) that may carry one or more contact lens molds, each having a lens formed therein, through various processes of the contact lens production facility as discussed in greater detail in copending contemporaneously filed case VTN-73 (see item 1 on the attached Concordance).

[0027] The pallet and conveyance and registration means is described in greater detail in copending contemporaneously filed case VTN-77 (see item 5 on the attached Concordance).

[0028] In the preferred embodiment as shown in Figure 10, one production line pallet 21 accommodates up to eight (8) contact lens molds 11 for simultaneous processing throughout the mold separation apparatus 10 and the first portion of the contact lens production line (not shown). As illustrated in Figure 2, each conveyor 13,14 comprises a parallel set of tracks 41a and 41b, each track 41a,b including a pair of tracking ribs 43a and 43b for mating with respective grooves 28a,b formed in the pallet 21. The paired set of ribs 43a,b and respective interlocking grooves 28a,b keep the pallet aligned as it is being conveyed within the demolding apparatus, and, as will be explained in detail below, prevents any vertical movement of the pallet 21 relative to the conveyor. A suitable registration means (not shown) is included for locating the pallets along the conveyor path for the demolding step.

[0029] The demolding assemblies 100a,100b of the mold separation apparatus 10 each physically pry the back curve half from the front curve half of each contact lens mold 11 to physically expose each contact lens situated in the lens mold for conveyance to a hydration station (not shown) located downstream of the apparatus 10 for hydration of the lenses. The prying process occurs under carefully controlled conditions, as will be explained in detail below, so that the back curve half 19 will be separated from the front curve half 17 without destroying the integrity of the lens 12 formed in the lens mold. To accomplish this, the mold separation apparatus 10 first prepares the back curve half 19 of each lens mold 11 to enable quick and efficient removal from its respective front curve 17 by applying a predetermined amount of heat, in the form of steam, to the back curve half surface. To fully understand the mold separation process it is necessary to describe the details of the contact lens mold itself.

[0030] As illustrated in Figures 2 and 3, soft contact lenses 12 are formed and polymerized in a mold cavity 25 formed between a front curve mold portion 17 and a back curve mold portion 19. The front curve portion 27 of the mold is carried within a recess 22 defined by pallet 21. In the formation of the lens, the front curve mold 17 is first partially filled with a monomer solution, and then the convex portion of back curve mold 19 is seated within the concave cavity of the front mold half under a vacuum to avoid the possibility of trapping an air bubble in the mold cavity. The mold halves are then weighted to squeeze them together to displace excess monomer into a space between flanges 26, 27. The assembled mold halves are then weighed again and precured in a low oxygen environment. Following precure, the lenses are fully cured with heat and UV radiation to fully polymerize the monomer matrix of the contact lens. These steps are described in greater detail in copending contemporaneously filed cases VTN-80 and VTN-83 (see items 8 and 11 on the attached Concordance).

[0031] Each front and back curve 17,19 additionally include respective circumferential flanges 26,27 formed at the circumferential periphery of each lens mold portion to facilitate the prying apart of the lens mold 11. As shown in Figure 3, the depth of the back curve 19, labeled "B" in the Figure, is approximately 4 mm. Also shown in Figure 3, is a gap "A" located between the circumferential edge portion 26,27 of each lens mold 11 which is approximately 1 mm to 3 mm wide. The gap "A" is preferably 2 mm wide for adequately receiving prying fingers of the demolding assemblies 100a,b that are inserted therein for prying apart of the front and back curve lens mold portions as will be described in greater detail below.

[0032] As shown in the general front plan views of Figures 4(a), each steam discharging apparatus 65a,65b generally comprises a plurality of individual nozzle assemblies 60 each mounted in mounting head assembly 67a,b at fixed locations corresponding to the location of each lens mold 11 seated in the pallet 21. Thus, in the preferred embodiment, there are eight (8) individual nozzle assemblies 60 positioned in each mounting head assembly 67a,b. For illustrative purposes, Figures 4(a) and 4(b) illustrate a nozzle assembly above conveyor line 13 and a vacuum assembly above conveyor line 14 to provide a view of the device at two different axis planes through the Figures. The apparatus of the present invention is symmetrical with respect to the major components thereof for each of the lines.

[0033] Each mounting head assembly 67a,b and the nozzle assemblies 60 therein are mounted on a first mounting platform 52 which moves in a plane transverse to conveyors 13,14. The first mounting platform 52 is caused to vertically reciprocate between a first upper position indicated as "A" in Figure 4(a), for a duration of time to allow the pallet 21 carrying the lens molds 11 to be registered beneath the mounting head assemblies 67a,b, and, a second lowered position indicated as "B" in Figure 4(b) whereby each nozzle assembly 60 is registered in sealing proximity with the surface 18 of the back curve mold portion 19 to direct steam at the surface. The mounting platform 52 is reciprocally driven by a plurality of screw nut motor assemblies.

[0034] In the top plan view of Figure 1, the mounting head assembly 67a of the steam discharging apparatus 65a includes two steam intake valves 66a,66b where pressurized steam is introduced from a suitable source into the assembly. Similar steam intake valves are present in the mounting head assembly 67b of the steam discharging apparatus 65b. A detailed front elevational view of steam discharging apparatus 65a is illustrated in Figure 11 and shows the mounting head assembly 67a comprising a cover assembly 150, a steam distribution manifold 130 located immediately beneath cover assembly 150 for distributing steam from each of the two steam intake valves 66a,66b to the eight individual steam nozzle assemblies 60, a condensate manifold 140 located immediately beneath steam distribution manifold 140 for removing and regulating the steam pressure applied to the back curve lens mold surface during steam

impingement, and a retaining plate 160 for retaining the individual steam discharge nozzles 60 and the steam intake valves 66b(,66a) in the apparatus. Also shown in Figure 11 is steam intake valve 66b that is positioned within assembly 67a and in cooperative engagement with the steam and condensate manifolds 130,140 as will be described in detail below. The steam intake valve 66b (and 66a) communicates with steam intake pipe 170 via plenum 169 to provide pressurized steam to the steam distribution manifold 130. Additionally, a vacuum source (not shown) is connected via suitable piping 172 to the condensate manifold 140 at input 171 to evacuate the steam and to regulate the steam pressure applied to the back curve lens mold surface during steam discharge.

[0035] A top plan view of the steam distribution manifold 130 of steam discharge apparatus 65a is illustrated in Figure 12(a). As shown in Figure 12(a), the steam distribution manifold 130 is provided with a set of hollowed bores 160 that each seat a respective steam discharge nozzle assembly 60, and hollowed bores 166a,b that seat respective steam intake valves 66a,66b. Each bore 166a,b is provided with four (4) conduits 168 that extend therefrom and communicate with a central axial bore of a respective individual steam discharge nozzle assembly 60 to provide steam to each nozzle as will be explained in detail below.

[0036] A top plan view of the condensate manifold 140 of steam discharge apparatus 65a is illustrated in Figure 12 (b). As shown in Figure 12(b), the condensate manifold 140 is also provided with a set of hollowed bores 161 each in axial alignment with the bores 160 of the steam discharge manifold, and bores 166c,d in axial alignment with the bores 166a,b of the steam discharge manifold for accommodating respective steam intake valves 66a,66b. Each bore 166c, d is provided with four (4) conduits 169 that extend therefrom and communicate with a hollowed annular ring of a respective individual steam discharge nozzle assembly 60 for removing steam, as will be explained in detail below. The condensate manifold 140 also defines a channel 165 that connects the vacuum source at input 171 with four of the hollowed bores 161 and the hollowed annular ring of a respective individual steam discharge nozzle assembly 60 when seated therein.

[0037] A detailed cross-sectional view of the steam intake valve 66b(66a) is shown in Figure 13. Steam at 100° C. is input from a suitable source, as indicated by the arrow B in Figure 13, through central axial bore 141 and distributed to radial bores 151 that are radially aligned with conduits 168 of the steam distribution manifold 130 when the valve is seated therein. Thus, steam is distributed from radial bores 151 via the conduits 168 to each of the individual steam discharge nozzles 60. In an alternative embodiment, the radial bores 151 may be replaced with a hollowed annular bore 151 that communicates with the central bore 141 of the steam intake valve and each of the conduits 168 of the steam distribution manifold. Figure 13 also illustrates the steam intake valve 66b(,66a) as provided with a circumferential annular indent 159, such that, when the valve is seated within the discharge apparatus, the indent 159 is aligned with four of the bores 161 and channel 165 and each of the conduits 169 of the condensate manifold 140. When the vacuum is applied to input 171 to relieve the steam pressure within the manifold, the alignment of the piping 165, indent 159, and conduits 169 assures that the vacuum will be supplied to each of the discharge nozzle assemblies 60. A set of O-rings 177a,b,c surrounding the periphery of the steam intake nozzle 66a(,66b) are provided and may be formed of EDPM or other suitable polymer to provide an air-tight seal when seated within the respective manifolds of the discharge apparatus.

[0038] A detailed cross-sectional view of an individual nozzle assembly 60 is shown in Figure 5. The nozzle 60 comprises a central axial bore 41 that forms a discharge orifice 42 located at the lower bottom 61 of the nozzle for discharging steam received from the steam distribution manifold 130. As mentioned above with respect to Figure 12 (a), the central axial bore 41 of a respective individual steam discharge nozzle assembly 60 receives pressurized steam from a respective conduit 168 of the steam manifold 130. Surrounding the centralized bore 41 is a hollowed annular ring 71 having a plurality of bores 43 extending therefrom, two of which 43a,43b are shown in the view of Figure 5, and which terminate in venting orifices 44a,44b located concentrically around discharge orifice 42. The annular ring 71 of each nozzle 60 communicates with bore 161 and a respective conduit 169 of the condensate manifold 140 so that the vacuum from the vacuum source will be supplied to the bores 43a,b of the nozzle 60. During operation, the venting orifices 44a,b will simultaneously exhaust the steam when steam is applied to the back curve lens mold surface through discharge orifice 42.

[0039] The physical dimensions of the nozzle assembly 60 are best illustrated in Figure 5. It comprises essentially a cylindrical upper end 62 having the discharge steam input orifice at the top surface thereof. A cylindrical lower end 61 that is smaller in diameter that the upper end has the discharge orifice 42 and venting orifices 44a,b. The diameter of the nozzle lower end 61 is in the range of approximately 12 mm to 18 mm, and is configured so that the discharge 42 and venting orifices 44a,b thereof protrude within the concave surface of the back curve lens 19 as shown in Figure 6(a) so as to direct steam directly at the back curve surface. The length of the nozzle lower end 61 that protrudes within the depth "B" of back curve 19 (Figure 3) is approximately 1 mm - 2.5 mm.

[0040] Also shown in Figure 5, surrounding the periphery of the nozzle upper and lower ends, are O-rings 63a,b,c that may be formed of EDPM or other suitable polymer for providing an air tight seal when the nozzle 60 is situated within the hollowed bores of the steam and condensate manifolds 130,140 of the mounting head assembly 67a(,b). As described in greater detail below, when the nozzle 60 is reciprocated to the back curve mold half 19, the O-ring 63c

of the lower nozzle end 61 forms a seal with the outer surface 18 of the back curve 19, as illustrated in Figure 6(a). The seal created between the O-ring 63c and the back curve mold creates a heating chamber between the nozzle and the back curve, and enables the steam discharged out of central discharge orifice 42 to be uniformly distributed along the outer surface of the back curve mold 19 thereby ensuring an even temperature profile along that portion of the back curve lens mold surface 18 that is adjacent the contact lens. Thus, a uniform temperature gradient is created between the back curve lens mold surface 18 and the contact lens 12 to aid in the separation of the lens mold 17 from the contact lens 12 in the mold separation apparatus 10. Furthermore, the vacuum exhaust ports 44(a)-(d) and the O-ring 63c (and the seal created with the back curve lens mold surface) prevent water condensation from forming on the back curve mold surface. Steam at a temperature ranging from 100°C to 130°C, but preferably 100°C, is discharged for approximately 2 - 4 seconds with the venting orifices 44a,b simultaneously removing the steam from the lens mold surface after impingement.

[0041] As illustrated in Figure 12(c), the cover assembly 150 of the mounting head assembly 67a,b, includes bores 167a,b for accommodating one or more heater cartridges (not shown) which function to keep the nozzle assembly 60 at a temperature that will prevent water condensation from forming on the nozzle surface and to assist in preventing water condensation from forming on the back curve surface 18. Preferably, the temperature of the heater cartridges are programmed to maintain the temperature of the nozzle at 100° degrees Celsius or greater. The cover assembly 150, as illustrated in the front elevational view of Figure 11, accommodates two heater cartridge inputs 153a,b connected with suitable heater cables 156a,b.

[0042] Each respective steam discharge assembly 65a,b of the mold separation apparatus 10 further includes a steam head retraction assembly 72a,b that enables each respective steam discharge assembly 65a,b to further reciprocate in a vertical direction relative to the mounting platform 52. As shown in the top plan view of Figure 1 and in the front view of Figure 4(b), each steam head retraction assembly 72a,b comprises a slidable mount 76 that is actuated to retract along a respective slide tower 79 from a steam discharging position, indicated by steam discharge apparatus 65a at position "C-C" (illustrated in Figure 4(b)), to a non-discharging position (indicated by steam discharge apparatus 65b in Figure 4(b) and apparatus 67a in Figure 4(a)) at position "D-D" to retract the mounting head assembly 67a,b and the steam nozzles 60 from the individual lens molds after applying steam thereto. Retracting each mounting head assembly 67a,b after discharging steam is necessary to permit the suction cup assemblies 90a,b to reciprocate to a position where individual suction cups 85, two of which are shown in Figure 4(b), are aligned with the eight lens mold back curves for removal from the pallet. Each steam head retraction assembly 72a,b is operable by means of a computer controlled stepper motor or by conventional pneumatic means (not shown).

[0043] The two suction cup assembly units 90a,b shown in Figures 4(a) and 6(b) are each mounted on the movable platform 52 and both reciprocate in both horizontal and vertical directions with respect to the pallets and mold parts. As shown in the detailed view of Figures 7, 8(a) and 8(b), each suction cup assembly unit 90 comprises a U-shaped mounting unit 88 having legs 89a,b that accommodate suction cups 85 positioned in a one-to-one correspondence with the individual contact lens molds 11 of a respective pallet. Thus, as illustrated in Figure 8(a) each leg 89a,b has four (4) suction cups that are spaced apart for gripping a respective back curve lens mold As mentioned generally above, each suction cup 85 of the suction cup assembly unit 90a,b vacuum grips a respective back curve of a corresponding lens mold after the prying operation described in detail below. The U-shaped mounting unit 88 and the legs 98a,b thereof reciprocate along fixed guided mounts 82 by conventional pneumatic means. The vacuum suction is provided to each of the plurality of suction cups 85 via conduit 91 shown in Figure 7.

[0044] After applying steam when the mounting platform 52 is in position "B" and each mounting head assembly 65a,b is in position "C-C" as illustrated in Figure 4(b), and, further, after pry fingers are inserted between the gap formed between the circumferential edge portions of each of the front and back curve molds to be discussed below, the mounting head assembly 65a (and 65b) and steam nozzles 60 thereof are caused to reciprocate to an upper position "D-D". This is accomplished by the steam head retraction assembly 72a,b in the manner described above to permit the suction cup assembly 90a, as shown in Figure 1, to extend from its non-gripping position indicated at "E-E", to its vacuum gripping position indicated at "F-F" so that each suction cup 85 is located above the surface of the back curve 19 of each lens mold 11.

[0045] In the preferred embodiment, the demolding assembly 100, shown in the top plan view of Figure 9, comprises two paired sets of pry tools 110a,b and 120a,b each corresponding to respective pallet conveyors 13,14. As shown in the Figure 9, the first set of four pry tools 110a and a second set of four pry tools 110b are located on respective opposite sides of the conveyor 13 to enable the removal of the back curve lens mold from the front curve for each of the eight lens molds situated in the registered pallet 21 as shown by the phantom lines on conveyor 13. Each set of tools 110a, b and 120a,b include upper and lower fingers which separate vertically, one from the other, in a manner to be herewith described in detail. Similarly, a first set of four pry tools 120a and a second set of four pry tools 120b are located on respective opposite sides of the conveyor 14 to enable the removal of the back curve lens mold from the front curve for each of the eight lens molds situated in the registered pallet shown by the phantom lines on conveyor 14. The description that follows is directed to one paired group of pry tools, e.g., 110a,b, but it is understood that the following

description applies equally to the other paired group of pry tools 120a,b for the pallet conveyed on conveyor 14.

[0046] Preferably, each of the respective group of pry tools 110a,b and 120a,b consist of a bottom group of contiguously connected U-shaped members 112 having finger portions 115 thereof, and a top group 114 of contiguously connected U-shaped mounting members having finger portions 116 thereof. As shown in the detailed side view of Figure 3, the top group of pry finger is situated directly above the bottom group of pry fingers and may be simultaneously inserted into the gap "A" of Figure 3 defined between the circumferential edge portion 26 of the back curve and the circumferential edge portion 27 of the front curve as described above. In the preferred embodiment, each group of pry tools are made of stainless steel and each set of fingers 115,116 range from 0.3 mm to 1.5 mm in thickness so that they may be precisely inserted within gap "A" (Figure 3). The top and bottom fingers 115,116 of pry tools 110a are further reciprocable in a vertical direction with respect to each other to perform a prying operation, as will be explained in detail below.

[0047] Immediately before or during the application of steam to the back curve lens mold surface 18 by the steam nozzles 60 as described above, the top finger 116 and bottom finger 115 of pry tools 110a,b are extended laterally toward each lens mold 11 in the direction indicated by the arrows C in Figure 9 so that both respective finger portions 115,116 are registered in the gap "A" (of Figure 3) defined between the circumferential flange portions 26,27 of each of the lens molds, as described above with respect to Figure 3. Both top and bottom sets of pry fingers 115,116 may be reciprocated in the lateral direction by conventional solenoid, stepper motor, of pneumatic means 121, shown generally in Figure 9.

[0048] The top fingers 116 and the U-shaped member 114 of the paired set 110a are vertically raised in an upward direction at a predetermined amount of time, preferably 1.5 seconds, after steam is applied to the back curve lens mold surface to bias each back curve lens mold from its respective front curve half for the eight lens molds situated in the registered pallet 21 in the monomer illustrated in Figure 3. In the preferred embodiment, the motion of the top set of pry fingers 116 is calculated so as to impart a predetermined amount of force of approximately 5.0 N to 40.0 N to effectively bias and remove the back curve halves from the front curve halves.

SUMMARY OF OPERATION

[0049] During operation, the first mounting platform 52 mounting steam discharge apparatus 65a and eight nozzles assemblies 60 is reciprocated to its first upper position labelled as position "A" in Figure 4(a) to allow a pallet 21 carrying up to eight lens molds each to come to a stop in registration beneath it so that the eight individual steam discharge nozzle assemblies 60 are in one-to-one correspondence with each of the eight contact lens molds 11 contained in the pallet 21 and conveyed by conveyors 13,14.

[0050] The first mounting platform 52 and steam discharge apparatus 65 thereof are then reciprocated to a second lower position labelled as position "B" in Figure 4(b) so that each EDPM O-ring 63c of nozzle 60 forms a seal between the lower discharging end 61 and the back lens mold curve 19. Then, steam at 100° C. is applied to the surface of the back curve 19, while the temperature of the front curve lens mold portion is maintained at a temperature ranging from 30° C. to 85° C. The sudden heating of the back curve 19 creates a temperature gradient between the back curve lens mold half and the contact lens. To enable minimum demold force, the optimum temperature gradient created between the back curve mold half and the contact lens by steam application ranges from 2.5° C. to 6° C.

[0051] As shown in Figure 6(a), during the time the steam discharge apparatus 65a and the steam nozzles 60 discharge steam to the back curve of the individual lens molds, the set 110a of pry fingers are extended, as indicated by the arrows, for insertion between the gaps formed between the respective front and back curves for each of the four lens molds situated on one side of the pallet 21. Likewise, the set 110b of pry fingers are extended for insertion between the gaps formed between the respective front and back curves of each of the four lens molds situated on the opposite side of the pallet 21 as shown in Figure 6(a).

[0052] As shown in detail in Figure 3, each set of pry tools 110a,b are inserted in a manner such that the fingers 115 of the bottom group 112 of pry tools thereof anchors the circumferential or annular rim portion 27 of the front curve of the lens mold to the surface of the pallet so that when the top group of pry tools 114 and fingers 116 thereof vertically separate (Figure 6(c)), the back curve mold portion of the lens mold will easily separate (Figure 6(c)) from the front curve mold portion without destroying the integrity of the contact lens 12 or either of the mold parts.

[0053] As illustrated in Figure 3, the use of a controlled lifting motion between pry fingers 115 and 116 tends to bow the convex portion 19(a) inwardly which will initiate a bilateral separation of the back curve lens, as denoted at 12(a) and 12(b). This, in turn, initiates a standing wave 12(c) in the material which travels downwardly along the convex surface of the back curve mold half. If the upward movement of the back curve mold half does not exceed the downward propagation rate of the standing wave in the material, then the back curve will be lifted cleanly without tearing the lens.

[0054] As the back curve is lifted free, it carries with it the excess HEMA ring 12(d) which may be preferentially retained on the back curve by means of corona treatment of the back curve, or by surfactant treatment of the front curve.

[0055] Next, as illustrated in Figure 6(b) after discharging the precision controlled amount of steam, the mounting

head assemblies 67a,b and the steam nozzles 60 thereof are retracted by the steam head retraction assembly 72 to enable the suction cup assembly unit 90a to extend from position "E-E" to position "F-F" (Figure 1) over the pallet and as shown in Figure 6(b).

[0056] During the separation step illustrated in Figure 6(c), the vacuum suction for the suction cup assembly 90a is activated, and the top group 114 of pry tools having fingers 116 are caused to separate from the lower group 112 of pry tools 115 to bias the circumferential edges of each of the back curves of each lens mold away from each of the front curves 17 which retain a respective contact lens therein and are anchored by the lower group of pry fingers 115. Thus, the back curve lens molds 19 are effectively removed from their respective front curve lens mold portions and retained by individual suction cups 85.

[0057] Finally, as shown in Figure 6(d), the upper and lower sets of pry fingers 115,116 are retracted laterally in opposite directions to allow each pallet 21 now containing up to eight front curve lens mold portions and a respective contact lens therein, to continue along its respective conveyor path, while the suction cups 85 retain the corresponding individual suction cups 80 for disposal. Preferably, the suction cup assembly 90a,b is retracted to its position "E-E" (Figure 1) and the vacuum may be removed therefrom so as to release the removed back curve lens mold portions. The separated mold parts are dropped in a bin at the retracted position, and evacuated by a vacuum line (not shown) for disposal.

[0058] While the invention has been particularly shown and described with respect to the preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein.

Concordance of Johnson & Johnson Vision Products Applications Filed on 9th June 1995

	J&J Ref.	Spec Ref.	C&R Ref.	Priority Appln. No.
1.	VTN-73	8997.KLK	P13914EP	USSN 257802
	Low oxygen molding of soft contact lenses.			
2.	VTN-74	8998.KLK	P13913EP	USSN 258556
	Automated method and apparatus for hydrating soft contact lenses.			
3.	VTN-75	8999.WCR	P13909EP	USSN 257801
	Laser demolding apparatus and method.			
4.	VTN-76	9000.WCR	P13908EP	USSN 257794
	Molding arrangement to achieve short mold cycle time.			
5.	VTN-77	9001-III.SF9	P13907EP	USSN 257786
	Contact lens production line pallet system.			
6.	VTN-78	9002.JSS	P13910EP	USSN 258267
	Apparatus for removing and transporting articles from molds.			
7.	VTN-79	9003-DTB	P13947EP	USSN 257785
	Mold halves and molding assembly for making contact lenses.			
8.	VTN-80	9004.KLK	P13950EP	USSN 258264
	Method and apparatus for contact lens mold filling and assembly.			

(continued)

Concordance of Johnson & Johnson Vision Products Applications Filed on 9th June 1995				
	J&J Ref.	Spec Ref.	C&R Ref.	Priority Appln. No.
9.	VTN-81	9005-KLK	P13949EP	USSN 257791
	Automated apparatus and method for consolidating products for packaging.			
10.	VTN-82	9006.SF9	P13948EP	USSN 258265
	Mold separation method and apparatus.			
11.	VTN-83	9007.KLK	P13945EP	USSN 257792
	Mold clamping and precure of a polymerizable hydrogel.			
12.	VTN-84	9008-LP	P13946EP	USSN 257871
	Method and apparatus for demolding ophthalmic contact lenses.			
13.	VTN-85	9009-LP	P13993EP	USSN 258263
	Method and apparatus for applying a surfactant to mold surfaces.			
14.	VTN-86	9010-KLK	P13995EP	USSN 258557
	Automated apparatus and method for preparing contact lenses for inspection and packaging.			
15.	VTN-87	9011-DTB	P13994EP	USSN 257799
	Ultraviolet cycling oven for polymerization of contact lenses.			
16.	VTN-88	9012-LP	P13997EP	USSN 257795
	Printed label structure for packaging arrangements.			
17.	VTN-91	9015.SF8	P13998EP	USSN 257800
	Computer system for quality control correlations.			
18.	VTN-92	9016.KLK	P13996EP	USSN 258654
	Consolidated contact lens molding.			
19.	VTN-93	9017.WCR	P13999EP	USSN 257787
	Packaging arrangement.			
20.	VTN-96	9166-II.SF6	P14005EP	USSN 257790
	Production line tracking and quality control system.			
21.	VTN-101	9292.JSS	P14009EP	USSN 257857
	Lens inspection system and method.			

(continued)

Concordance of Johnson & Johnson Vision Products Applications Filed on 9th June 1995				
	J&J Ref.	Spec Ref.	C&R Ref.	Priority Appln. No.
22.	VTN-102	9293.JSS	P14007EP	USSN 258340
	System and method for inspecting lenses.			
23.	VTN-140	9119.JSS	P14008EP	USSN 258266
	A method of positioning ophthalmic lenses.			
24.	VTN-150	9167.SF5	P14006EP	USSN 257793
	Interactive control system for packaging control.			
25.	VTN-151	9168-LP	P14003EP	USSN 257789
	Apparatus and method for preparing printing labels.			
26.	VTN-152	9169-LP	P14004EP	USSN 257788
	Apparatus and method for sterilization and secondary packaging.			

Claims

1. An apparatus (10) for separating individual contact lens mold assemblies (100a, 100b), each of said assemblies having a contact lens mold (25) between a front mold half (17) and a back mold half (19), each of said mold halves having annular circumferential flanges (26, 27), said apparatus comprising means for demolding, said means including a prying means (110a, b) for insertion between said circular circumferential flanges (26, 27) of each said front mold and back mold halves (17, 19) of said contact lens mold assembly (11), said prying means including a first set of pry fingers (115) and a second set of pry fingers (116), and;

   first means (65a, b) for applying steam at a first temperature to said back mold half to form a temperature gradient in the range of 2.5°C to 6.0°C between said back mold half (19) relative to said front mold half (17);

   wherein said first set of pry fingers (115) of said demolding means are for retaining said front mold half (17), and said second set of pry fingers (116) of said demolding means are for biasing said back mold half (19) upwardly at a predetermined force with respect to said front mold half (17) to effectively remove said back mold half (19) therefrom.

2. The apparatus for separating individual mold assemblies as claimed in claim 1 further including a vacuum gripping means (85) associated with a said contact lens mold assembly, wherein said vacuum gripping means (85) simultaneously grips said back mold half while said back mold half is removed from its respective front mold half.

3. The apparatus for separating individual mold assemblies as claimed in claim 1 wherein said prying means includes means for displacing said first set of pry fingers in a substantially vertical direction to lift said circular circumferential flange at sides of each of said back mold halves and to remove each of said back mold halves from respective front mold halves.

4. The apparatus for separating individual mold assemblies as claimed in claim 3 wherein said second set of pry fingers is positioned to anchor said front mold halves while said first set of pry fingers biases said back mold halves upwardly.

5. The apparatus for separating individual mold assemblies as claimed in claim 4 wherein each first and second set of pry fingers are extensible from a first retracted position to a second extended position between said circular circumferential edges of each said front mold and back mold halves of said contact lens mold assembly.

6. The apparatus for separating individual mold assemblies as claimed in claim 1 wherein said first means for applying steam comprises means for applying (130) a predetermined amount of steam.

7. The apparatus for separating individual mold assemblies as claimed in claim 6 wherein said first means for applying steam includes a means for discharging steam through a nozzle (60) associated with a contact lens mold assembly.

8. The apparatus for separating individual mold assemblies as claimed in claim 6 which further includes a pallet means (21) for transporting a plurality of contact lens mold assemblies therein, said pallet means being registered proximate said steam applying means prior to said steam to said discharge at back curve mold surfaces.

9. The apparatus for separating individual mold assemblies as claimed in claim 8 wherein said first means further including means for advancing (72) said steam discharging means from a first position to a second position at said registered pallet prior to discharging steam to each said back mold surfaces, and retracting said steam applying means away from said registered pallet towards said first position after discharging steam at each said back mold surfaces.

10. The apparatus for separating individual mold assemblies as claimed in claim 9 further including a gripping means (85) associated with a said contact lens mold assembly for gripping said back mold half while said back mold half is separated from its respective front mold half.

11. The apparatus for separating individual mold assemblies as claimed in claim 10 further including means for extending said gripping means towards said pallet after said steam discharging means is retracted away from said pallet.

12. The apparatus for separating individual mold assemblies as claimed in claim 10 further including a means for generating a vacuum for said gripping means to enable said gripping means to grip a respective said back curve mold surface after application of steam thereto.

13. The apparatus for separating individual mold assemblies as claimed in claim 11 wherein said means for extending said gripping means further retracts said gripping means to a retracted position while said gripping means is gripping a separated individual back mold portion.

14. The apparatus for separating individual mold assemblies as claimed in claim 13 wherein said means for generating a vacuum further includes means for breaking said vacuum to discharge said back mold portions from its associated gripping means at said retracted position.

15. The apparatus for separating individual mold assemblies as claimed in claim 1 wherein said first set of pry fingers is a contiguous set of U-shaped legs (112) that substantially conform to fit between said circular circumferential flanges of each said front mold and back mold halves.

16. The apparatus for separating individual mold assemblies as claimed in claim 15 wherein said second set of pry fingers is a contiguous set of U-shaped legs (114) that substantially conform to said mold halves and fit between said circular circumferential flanges of each said front mold and back mold halves to effectively anchor each of said front mold halves while said first set of pry fingers biases said back mold halves upwardly for removal.

17. An apparatus (10) for separating a back mold half (19) from a front mold half (17) of a contact lens mold assembly (11) useful in the production of a contact lens (12), each said front and back mold halves (17, 19) having a central curved section defining a concave surface, a convex surface, and a circular circumferential edge (26, 27), at least part of at least one of said concave surface and said convex surface having the dimensions of the front or back curve, respectively, of a contact lens (12) to be produced in said mold assembly (11), said apparatus comprising prying means (100a, b) for insertion between said circular circumferential edges (26, 27) of each said front mold and back mold halves (17, 19) of said contact lens mold assembly (11), said prying means (100a, b) including a first and second sets of pry fingers (115, 116), and;

means for applying steam (65a, b) to said concave surface (18) of said back mold half (19) while maintaining said convex surface of said front mold half at a first temperature to form a temperature gradient in the range of 2.5°C to 6.0°C between said convex surface (18) of said back mold half (19) and said concave surface of said front mold half (17), and, resultingly, a temperature gradient across said contact lens (12); and,

wherein said first and second sets of pry fingers (115, 116) of said prying means (100a, b) are for biasing

said back mold half (19) upwardly at a predetermined force with respect to said front mold half (17) to effectively remove said back mold half (19) therefrom.

18. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 17 further including a gripping means (85) associated with a said contact lens mold assembly, wherein said gripping means simultaneously grips said back mold half while said back mold half is removed from its respective front mold half.

19. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 17 wherein said prying means includes means for displacing said first set of pry fingers in a substantially vertical direction to lift said circular circumferential flange of each of said back mold halves and remove each of said back mold halves from respective front mold halves.

20. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 19 wherein said second set of pry fingers are inserted between said circular circumferential flanges of each said front mold and back mold halves of said contact lens mold assembly and positioned to anchor said front mold halves while said first set of pry fingers biases said back mold halves upwardly.

21. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 20 wherein each first and second set of pry fingers are extendible from a first retracted position to a second extended position between said circular circumferential flanges of each said front mold and back mold halves of said contact lens mold assembly.

22. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 17 wherein said means for applying steam to said concave surface of said back mold half includes nozzle means (60) for discharging steam for impingement upon a surface of said back mold half, said nozzle means including a nozzle body connected to a steam supply source (130) and a nozzle head (61) having a steam discharge orifice (42).

23. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 22 wherein said means for applying steam to said concave surface of said back mold half includes means for simultaneously exhausting steam (44a, b) to prevent application of excessive steam pressure to said back mold half.

24. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 22 wherein said nozzle means includes one or more said venting orifices connected with a vacuum source for simultaneously venting steam away from said mold surface during steam impingement thereof.

25. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 22 wherein said means for applying steam to said concave surface of said back mold half further includes means (72) for positioning said nozzle means in close proximity with a surface of said back mold half prior to discharging steam and for retracting said nozzle means away from said back mold surface after steam impingement thereon.

26. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 17 wherein said means for applying steam to said concave surface of said back mold half includes nozzle means for discharging steam for impingement upon a surface of said back mold half, said nozzle means including a nozzle body connected to a steam supply source and a nozzle head having a steam orifice, said nozzle means further including a means for creating a substantial air-tight seal between said nozzle head and said back mold surface prior to steam impingement thereupon.

27. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 26 wherein said means for creating a substantial seal is an O-ring gasket formed around a periphery of said nozzle head.

28. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 27 wherein said O-ring gasket is made of EDPM.

29. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 22 wherein said means for applying steam to said concave surface of said back mold half further includes heater means for vaporizing any existing condensation that may form on a surface within said nozzle body.

30. The apparatus for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 29 wherein said heater means includes cartridge heaters located in predetermined locations in said nozzle means.

31. A method of separating a back mold half (19) from a front mold half (17) of a contact lens mold assembly (11) useful in the production of a contact lens (12), each said front and back mold halves (17, 19) having a central curved section defining a concave surface, a convex surface, and a circular circumferential flange, at least part of at least one of said concave surface and said convex surface having the dimensions of the front or back curve, respectively, of a contact lens (12) to be produced in said mold assembly (11), said method comprising the steps of:

(a) inserting a first set of pry fingers (115) between said circular circumferential flanges (26, 27) of each said front mold (17) and back mold halves (19) of said contact lens mold assembly (11);
(b) applying a predetermined amount of steam to said back curve lens mold surface to form a temperature gradient between said back mold half relative to said front mold half; and
(c) biasing said first set of pry fingers (115) in a substantially vertical direction so as to simultaneously remove said back mold half (19) from its associated front mold half (17);

wherein said temperature gradient ranges from 2.5°C to 6.0°C.

32. The method of separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 31 comprising the step of creating a substantial air-tight seal between said back mold surface and a first nozzle means for discharging steam for impingement upon a surface of said back mold half, said nozzle means including a nozzle body connected to a steam supply source, a nozzle head having a steam discharge orifice and means for creating a substantial air-tight seal between said nozzle head and said back mold surface.

33. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 31 further including the step of gripping said back mold surface with a gripping means (85) prior to removing said back mold half from its associated front mold half.

34. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 33 further including the step (e) of retracting said first set of pry fingers while said gripping means retains each said back mold half for disposal thereof.

35. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 31 wherein the step (d) of biasing said first set of pry fingers in a substantially vertical direction, includes the step of simultaneously anchoring each said front mold halves to prevent lifting thereof.

36. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 31 wherein the step (b) of applying a predetermined amount of steam to said back mold surface further includes the step of simultaneously venting steam to thereby regulate the amount of steam applied to said back mold surface.

37. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 36 wherein the step (b) of applying a predetermined amount of steam to said back mold surface further includes the step of creating the temperature gradient across said front and back mold halves.

38. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 37 wherein the step of creating the temperature gradient further includes the step of maintaining said front mold half at a temperature ranging from 30 °C. to 85 °C. while applying steam to said back mold half.

39. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 31 wherein prior to step (a), said method further includes the step of registering a pallet (21) containing one or more said contact lens mold assemblies proximate a steam applying means (65a, b) having a plurality of steam discharge nozzles (60), wherein each said back curve is in registration with a respective steam discharge nozzle

(60).

40. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 31, wherein the temperature of said steam applied to said back mold surface ranges from 100°C to 130°C.

41. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 40, wherein said convex surface of said front mold half is maintained at a temperature ranging from 30°C to 85°C while said steam is being applied to said back mold surface.

42. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 31, wherein biasing said first set of pry fingers in a substantially vertical direction so as simultaneously remove said back mold half from its associated front mold half occurs at a predetermined time after application of said steam.

43. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 42, wherein said predetermined time ranges from 1.0 to 5.0 seconds.

44. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 42, wherein said predetermined time is about 1.5 seconds.

45. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 31 wherein said first set of pry fingers in are biased in a substantially vertical direction so as simultaneously remove said back mold half from its associated front mold half at a predetermined constant force ranging from about 5 N to 40 N.

46. The method for separating a back mold half from a front mold half of a contact lens mold assembly as claimed in claim 31 wherein said first set of pry fingers are inserted between said circular circumferential flanges of each said front mold and back mold halves of said contact lens mold assembly while a predetermined amount of steam is applied to said back mold surface.

47. A steam nozzle assembly (60) for heating a back mold half (19) of a contact lens mold assembly (11), wherein said assembly (11) includes a contact lens (12) molded between a front curve half (17) and a back curve half (19), said nozzle assembly (60) including:

(a) a plurality of steam nozzles (60) for engaging a plurality of contact lens mold assemblies (11), each of said nozzles (60) including:

(i) means for sealing (63) said nozzle (60) to said mold assembly (11) to create a heating chamber between said nozzle and said contact lens mold assembly (11);
(ii) a steam orifice (42) for discharging steam into said heating chamber; and
(iii) at least one port (44) defined in each of said nozzles (60) for exhausting steam from said heating chamber.

(b) means for moving (72) said steam nozzles (60) into engagement with said contact lens mold assemblies (11);
(c) a first plenum for distributing steam to each of said nozzle assemblies; and
(d) a second plenum for drawing a vacuum through said vent ports to exhaust steam from said heating chamber whereby a temperature gradient may be created between said back curve mold half and the contact lens in said mold assembly.

48. A steam nozzle assembly as claimed in claim 47, which further includes a means for supplying (130) a predetermined amount of steam to said heating chamber.

49. A steam nozzle assembly as claimed in claim 47 wherein said means for moving said steam nozzles into engagement with said contact lens mold assembly further includes means for advancing said nozzles into close proximity with a surface of said back mold half prior to discharging steam and for retracting said nozzle means away from said back mold surface after steam impingement thereon.

50. A steam nozzle assembly as claimed in claim 47 wherein said means for sealing said nozzle to said mold assembly further includes a means for creating a substantial air-tight seal between said nozzle head and said back mold surface prior to steam impingement thereupon.

51. A steam nozzle assembly as claimed in claim 50 wherein said means for creating a substantial seal is an O-ring gasket formed around a periphery of said nozzle head.

52. A steam nozzle assembly as claimed in claim 47 which further includes a heater means (153a, b) for vaporizing any condensation that may form on a surface within the nozzle assembly.

53. A steam nozzle assembly as claimed in claim 52 wherein said heater means includes cartridge heaters located in predetermined locations in said nozzle means.

54. A steam nozzle assembly as claimed in claim 47 which further includes a plurality of vent orifices (44a, b) which surround said steam orifice.

55. A steam nozzle assembly as claimed in claim 48 which further includes a control means and a valve means for supplying said predetermined amount of steam.

Patentansprüche

1. Vorrichtung (10) zum Trennen einzelner Kontaktlinsenform-Einrichtungen (100a, 100b), von denen jede ein Kontaktlinsenformstück (25) zwischen einer vorderen Formhälfte (17) und einer hinteren Formhälfte (19) aufweist, wobei jede Formhälfte einen ring- oder kreisförmigen Umfangsflansch (26, 27) aufweist, wobei die Vorrichtung umfaßt: eine Einrichtung zum Entfernen der Formen, welche Einrichtung eine Aufstemmeinrichtung (110a, b) umfaßt, die zwischen den kreisförmigen Umfangsflanschen (26, 27) jeder vorderen und hinteren Formhälfte (17, 19) der Kontaktlinsenformeinrichtung (11) einbringbar ist, wobei die Aufstemmeinrichtung einen ersten Satz Stemmfinger (115) und einen zweiten Satz Stemmfinger (116) umfaßt, und;
eine Einrichtung (65a, b), welche die hintere Formhälfte bei einer ersten Temperatur mit Dampf beaufschlagen kann, um einen Temperaturgradienten in dem Bereich von 2,5°C bis 6,0°C zwischen der hinteren Formhälfte (19) und der vorderen Formhälfte (17) zu bilden;
wobei der erste Satz Stemmfinger (115) der Einrichtung zum Entfernen der Formen dazu ausgelegt ist, die vordere Formhälfte (17) zu halten, und der zweite Satz Stemmfinger (116) der Einrichtung zum Entfernen der Formen dazu ausgelegt ist, die hintere Formhälfte (19) mit einer vorbestimmten Kraft mit Bezug auf die vordere Formhälfte (17) nach oben vorzuspannen, um die hintere Formhälfte (19) von der vorderen Formhälfte effektiv zu entfernen.

2. Vorrichtung nach Anspruch 1 mit einer Vakuumgreifeinrichtung (85), die einer Kontaktlinsenform-Einrichtung zugeordnet ist, wobei die Vakuumgreifeinrichtung (85) gleichzeitig die hintere Formhälfte greift, während die hintere Formhälfte von ihrer zugehörigen vorderen Formhälfte getrennt wird.

3. Vorrichtung nach Anspruch 1, bei der die Aufstemmeinrichtung eine Einrichtung zum Versetzen des ersten Satzes Stemmfinger in einer im wesentlichen vertikalen Richtung umfaßt, um den kreisförmigen Umfangsflansch an Seiten jeder hinteren Formhälfte anzuheben und jede hintere Formhälfte von der zugehörigen vorderen Formhälfte zu entfernen.

4. Vorrichtung nach Anspruch 3, bei welcher der zweite Satz Stemmfinger derart positioniert ist, daß die vorderen Formhälften festgehalten werden, während der erste Satz Stemmfinger die hinteren Formhälften nach oben vorspannt.

5. Vorrichtung nach Anspruch 4, bei welcher der erste und zweite Satz Stemmfinger von einer ersten eingefahrenen Position in eine zweite ausgefahrene Position zwischen den kreisförmigen Umfangsrändern jeder vorderen und hinteren Formhälfte der Kontaktlinsenform-Einrichtung ausfahrbar sind.

6. Vorrichtung nach Anspruch 1, bei der die erste Einrichtung zur Dampfbeaufschlagung eine Einrichtung (130) zum Beaufschlagen mit einer vorbestimmten Dampfmenge umfaßt.

7. Vorrichtung nach Anspruch 6, bei der die erste Einrichtung zur Dampfbeaufschlagung eine Einrichtung zum Ab-

geben von Dampf durch eine Düse (60) hindurch umfaßt, die einer Kontaktlinsenform-Einrichtung zugeordnet ist.

8. Vorrichtung nach Anspruch 6, die eine Paletteneinrichtung (21) zum Fördern mehrerer Kontaktlinsenform-Einrichtungen darin umfaßt, wobei die Paletteneinrichtung in der Nähe der Dampfbeaufschlagungseinrichtung vor der Dampfabgabe an hinteren, gewölbten Formflächen registriert wird.

9. Vorrichtung nach Anspruch 8, bei der die erste Einrichtung eine Einrichtung (72) zum Vorbewegen der Dampfabgabeeinrichtung aus einer ersten Position in eine zweite Position an der registrierten Palette, bevor Dampf an jede hintere Formfläche abgegeben wird, und zum Zurückbewegen der Dampfabgabeeinrichtung von der registrierten Palette weg hin zur ersten Position, nachdem Dampf an jede hintere Formfläche abgegeben wurde.

10. Vorrichtung nach Anspruch 9, mit einer Greifeinrichtung (85), die einer Kontaktlinsenform-Einrichtung zugeordnet ist, um die hintere Formhälfte zu greifen, während die hintere Formhälfte von ihrer zugeordneten vorderen Formhälfte getrennt wird.

11. Vorrichtung nach Anspruch 10 mit einer Einrichtung zum Ausfahren der Greifeinrichtung hin zur Palette, nachdem die Dampfbeaufschlagungseinrichtung von der Palette weg zurückbewegt oder -gezogen wurde.

12. Vorrichtung nach Anspruch 10 mit einer Einrichtung zum Erzeugen eines Vakuums für die Greifeinrichtung, damit die Greifeinrichtung eine zugeordnete hintere gewölbte Formfläche greifen kann, nachdem die hintere Formfläche mit Dampf beaufschlagt wurde.

13. Vorrichtung nach Anspruch 11, bei der die Einrichtung zum Ausfahren der Greifeinrichtung die Greifeinrichtung in eine eingefahrene Position zurückbringt, während die Greifeinrichtung einen getrennten einzelnen hinteren Formabschnitt greift.

14. Vorrichtung nach Anspruch 13, bei der die Einrichtung zum Erzeugen eines Vakuums eine Einrichtung zum Aufheben des Vakuums umfasst, um die hinteren Formabschnitte von ihrer zugeordneten Greifeinrichtung in der eingefahrenen Position zu lösen.

15. Vorrichtung nach Anspruch 1, bei welcher der erste Satz Stemmfinger ein zusammenhängender Satz U-förmige Schenkel (112) ist, die im wesentlichen zwischen den kreisförmigen Umfangsflanschen jeder vorderen und hinteren Formhälfte passen.

16. Vorrichtung nach Anspruch 15, bei dem der zweite Satz Stemmfinger ein zusammenhängender Satz U-förmige Schenkel (114) ist, die mit den Formhälften im wesentlichen übereinstimmen und zwischen den kreisförmigen Umfangsflanschen jeder vorderen und hinteren Formhälfte passen, um effektiv jede vordere Formhälfte festzuhalten, während der erste Satz Stemmfinger die hinteren Formhälften zum Entfernen nach oben vorspannt.

17. Vorrichtung zum Trennen einer hinteren Formhälfte (19) von einer vorderen Formhälfte (17) einer Kontaktlinsenform-Einrichtung (11), die für die Produktion einer Kontaktlinse (12) verwendet werden kann, wobei jede vordere und hintere Formhälfte (17, 19) einen zentralen gewölbten Abschnitt aufweisen, der eine konkave Fläche, eine konvexe Fläche und einen kreisförmigen Umfangsrand (26, 27) definiert, wobei zumindest ein Teil der konkaven Fläche oder der konvexen Fläche die Abmessungen der vorderen oder hinteren Wölbung einer Kontaktlinse (12) aufweist, die in der Formeinrichtung (11) herzustellen ist, wobei die Vorrichtung umfaßt:

eine Aufstemmeinrichtung (110a, b), die zwischen den kreisförmigen Umfangsrändern (26, 27) jeder vorderen und hinteren Formhälfte (17, 19) der Kontaktlinsenform-Einrichtung (11) einbringbar ist, wobei die Aufstemmeinrichtung (100a, b) einen ersten und einen zweiten Satz Stemmfinger (115, 116) umfaßt, und;

eine Einrichtung (65a, b) zur Dampfbeaufschlagung der konkaven Fläche (18) der hinteren Formhälfte (19), während die konvexe Fläche der vorderen Formhälfte bei einer ersten Temperatur gehalten wird, um einen Temperaturgradienten in dem Bereich von 2,5°C bis 6°C, zwischen der konvexen Fläche (18) der hinteren Formhälfte (19) und der konkaven Fläche der vorderen Formhälfte (17) und folglich einen Temperaturgradienten quer durch die Kontaktlinse (12) zu bilden; und

wobei der erste und zweite Satz Stemmfinger (115, 116) der Aufstemmeinrichtung (100a, b) zum Vorspannen der hinteren Formhälfte (19) mit einer vorbestimmten Kraft nach oben bezüglich der vorderen Formhälfte (17) ausgelegt ist, um effektiv die hintere Formhälfte (19) von der vorderen Formhälfte (17) zu entfernen.

18. Vorrichtung nach Anspruch 17 mit einer Greifeinrichtung (85), die der Kontaktlinsenform-Einrichtung zugeordnet ist, wobei die Greifeinrichtung gleichzeitig die hintere Formhälfte greift, während die hintere Formhälfte von ihrer zugeordneten vorderen Formhälfte entfernt wird.

19. Vorrichtung nach Anspruch 17, bei der die Aufstemmeinrichtung eine Einrichtung zum Versetzen des ersten Satzes Stemmfinger in eine im wesentlichen vertikalen Richtung umfaßt, um den kreisförmigen Umfangsflansch jeder hinteren Formhälfte anzuheben und jede hintere Formhälfte von der zugeordneten vorderen Formhälfte zu entfernen.

20. Vorrichtung nach Anspruch 19, bei welcher der zweite Satz Stemmfinger zwischen den kreisförmigen Umfangsflanschen jeder vorderen und hinteren Formhälfte der Kontaktlinsenform-Einrichtung eingebracht und derart positioniert ist, daß die vorderen Formhälften festgehalten werden, wenn der erste Satz Stemmfinger die hinteren Formhälften nach oben vorspannt.

21. Vorrichtung nach Anspruch 20, bei welcher der erste und der zweite Satz Stemmfinger von einer ersten eingefahrenen Position in eine zweite ausgefahrene Position zwischen den kreisförmigen Umfangsflanschen jeder vorderen und hinteren Formhälfte der Kontaktlinsenform-Einrichtung ausfahrbar sind.

22. Vorrichtung nach Anspruch 17, bei der die Einrichtung zur Dampfbeaufschlagung der konkaven Fläche der hinteren Formhälfte eine Düseneinrichtung (60) zum Abgeben von Dampf umfaßt, um Dampf auf eine Fläche der hinteren Formhälfte auftreffen zu lassen, wobei die Düseneinrichtung einen Düsenkörper, der an eine Dampfversorgungsquelle (130) angeschlossen ist, und einen Düsenkopf (61) umfaßt, der eine Dampfabgabeöffnung (42) aufweist.

23. Vorrichtung nach Anspruch 22, bei der die Einrichtung zur Dampfbeaufschlagung der konkaven Fläche der hinteren Formhälfte eine Einrichtung (44a, b) zum gleichzeitigen Ausströmen von Dampf umfaßt, um zu verhindern, daß der hinteren Formhälfte kein übermäßig hoher Dampfdruck mitgeteilt wird.

24. Vorrichtung nach Anspruch 22, bei der die Düseneinrichtung eine oder mehrere Ausströmöffnungen umfaßt, die an eine Vakuumquelle angeschlossen sind, um gleichzeitig Dampf von der Formfläche weg abzuziehen, während der Dampf auf die Formfläche auftrifft.

25. Vorrichtung nach Anspruch 22, bei der die Einrichtung zur Dampfbeaufschlagung der konkaven Fläche der hinteren Formhälfte eine Einrichtung (72) zum Positionieren der Düseneinrichtung in unmittelbarer Nähe einer Fläche der hinteren Formhälfte, bevor Dampf abgegeben wird, und zum Zurückbringen der Düseneinrichtung von der hinteren Formfläche weg umfaßt, nachdem Dampf auf die hintere Formfläche aufgetroffen ist.

26. Vorrichtung nach Anspruch 17, bei der die Einrichtung zur Dampfbeaufschlagung der konkaven Fläche der hinteren Formhälfte eine Düseneinrichtung zum Abgeben von Dampf umfaßt, um Dampf auf eine Fläche der hinteren Formhälfte auftreffen zu lassen, wobei die Düseneinrichtung einen Düsenkörper, der an eine Dampferzeugungsquelle angeschlossen ist, und einen Düsenkopf mit einer Dampföffnung umfaßt, wobei die Düseneinrichtung eine Einrichtung zum Erzeugen einer dauerhaften luftdichten Dichtung zwischen dem Düsenkopf und der hinteren Formfläche umfaßt, bevor Dampf auf die hintere Formfläche auftreffen wird.

27. Vorrichtung nach Anspruch 26, bei der die Einrichtung zum Erzeugen einer dauerhaften Dichtung eine O-Ringdichtung ist, die am Umfang des Düsenkopfs ausgebildet ist.

28. Vorrichtung nach Anspruch 27, bei der die O-Ringdichtung aus EDPM besteht.

29. Vorrichtung nach Anspruch 22, bei der die Einrichtung zur Dampfbeaufschlagung der konkaven Fläche der hinteren Formhälfte eine Heizeinrichtung zum Verdampfen jedes existierenden Kondensats umfaßt, das sich an einer Fläche innerhalb des Düsenkörpers ausbilden kann.

30. Vorrichtung nach Anspruch 29, bei der die Heizeinrichtung Heizpatronen umfaßt, die an vorbestimmten Stellen in der Düseneinrichtung angeordnet sind.

31. Verfahren zum Trennen einer hinteren Formhälfte (19) von einer vorderen Formhälfte (17) einer Kontaktlinsenform-Einrichtung (11), die für die Produktion einer Kontaktlinse (12) verwendet werden kann, wobei jede vordere und hintere Formhälfte (17, 19) einen zentralen gewölbten Abschnitt aufweist, der eine konkave Fläche, eine konvexe

Fläche und einen kreisförmigen Umfangsflansch definiert, wobei zumindest ein Teil der konkaven Fläche oder der konvexen Fläche die Abmessungen der vorderen oder hinteren Wölbung einer Kontaktlinse (12) aufweist, die in der Formeinrichtung (11) herzustellen ist, wobei:

(a) ein erster Satz Stemmfinger (115) zwischen den kreisförmigen Umfangsflanschen (26, 27) jeder vorderen (17) und hinteren Formhälfte (19) der Kontaktlinsenform-Einrichtung (11) eingebracht wird;
(b) die hintere gewölbte Linsenformfläche mit einer vorbestimmten Dampfmenge beaufschlagt wird, um einen Temperaturgradienten zwischen der hinteren Formhälfte und der vorderen Formhälfte zu bilden; und
(c) der erste Satz Stemmfinger (115) in einer im wesentlichen vertikalen Richtung vorgespannt wird, um die hintere Formhälfte (19) von ihrer zugeordneten vorderen Formhälfte (17) zu entfernen;

wobei der Temperaturgradient in einem Bereich von 2,5°C bis 6,0°C liegt.

32. Verfahren nach Anspruch 31, bei dem eine dauerhafte luftdichte Dichtung zwischen der hinteren Formhälfte und einer ersten Düseneinrichtung zur Abgabe von Dampf geschaffen wird, um Dampf auf eine Fläche der hinteren Formhälfte auftreffen zu lassen, wobei die Düseneinrichtung einen Düsenkörper, der an eine Dampfversorgungsquelle angeschlossen ist, einen Düsenkopf mit einer Dampfausgabeöffnung und eine Einrichtung zum Erzeugen einer dauerhaften luftdichten Dichtung zwischen dem Düsenkörper und der hinteren Formfläche umfaßt.

33. Verfahren nach Anspruch 31, bei dem die hintere Formfläche mittels einer Greifeinrichtung (85) gegriffen wird, bevor die hintere Formhälfte von ihrer zugeordneten vorderen Formhälfte entfernt wird.

34. Verfahren nach Anspruch 33, bei dem (e) der erste Satz Stemmfinger zurückgebracht wird, während die Greifeinrichtung jede hintere Formhälfte für deren Beseitigung hält.

35. Verfahren nach Anspruch 31, wobei beim Vorspannen des ersten Satzes Stemmfinger in einer im wesentlichen vertikalen Richtung gemäß Verfahrensschritt (d) jede vordere Formhälfte gleichzeitig festgehalten wird, um ein Anheben jeder vorderen Formhälfte zu verhindern.

36. Verfahren nach Anspruch 31, wobei beim Beaufschlagen der hinteren Formfläche mit einer bestimmten Dampfmenge gemäß Verfahrensschritt (b) der Dampf gleichzeitig abgezogen wird, wodurch die Dampfmenge reguliert wird, mit der die hintere Formfläche beaufschlagt wird.

37. Verfahren nach Anspruch 36, wobei beim Beaufschlagen der hinteren Formfläche mit einer vorbestimmten Dampfmenge gemäß Verfahrensschritt (b) der Temperaturgradient quer durch die vordere und hintere Formhälfte erzeugt wird.

38. Verfahren nach Anspruch 37, wobei beim Erzeugen des Temperaturgradienten die vordere Formhälfte bei einer Temperatur gehalten wird, die in einem Bereich von 30°C bis 85°C liegt, während die hintere Formhälfte mit Dampf beaufschlagt wird.

39. Verfahren nach Anspruch 31, bei dem vor dem Verfahrensschritt (a) eine Palette (21) registriert wird, die eine oder mehrere Kontaktlinsenform-Einrichtungen in der Nähe einer Dampfbeaufschlagungseinrichtung (65a, b) enthält, die mehrere Dampfabgabedüsen (60) aufweist, wobei jede hintere Wölbung von einer zugeordneten Dampfabgabedüse (60) registriert wird.

40. Verfahren nach Anspruch 31, wobei die Temperatur des Dampfes, mit dem die hintere Formfläche beaufschlagt wird, in einem Bereich von 100°C bis 130°C liegt.

41. Verfahren nach Anspruch 40, bei dem die konvexe Fläche der vorderen Formhälfte bei einer Temperatur gehalten wird, die in einem Bereich von 30°C bis 85°C liegt, während die hintere Formfläche mit dem Dampf beaufschlagt wird.

42. Verfahren nach Anspruch 31, bei dem zum gleichzeitigen Entfernen der hinteren Formhälfte von ihrer zugeordneten vorderen Formhälfte der erste Satz Stemmfinger in einer im wesentlichen vertikalen Richtung dann vorgespannt wird, nachdem ein vorbestimmter Zeitabschnitt ab der Dampfbeaufschlagung verstrichen ist.

43. Verfahren nach Anspruch 42, bei dem der vorbestimmte Zeitabschnitt 1,0 bis 5,0 Sekunden dauert.

44. Verfahren nach Anspruch 42, bei dem der vorbestimmte Zeitabschnitt ungefähr 1,5 Sekunden dauert.

45. Verfahren nach Anspruch 31, bei dem der erste Satz Stemmfinger in einer im wesentlichen vertikalen Richtung vorgespannt wird, um die hintere Formfläche von ihrer zugeordneten vorderen Formfläche mit einer vorbestimmten konstanten Kraft zu entfernen, die in einem Bereich von ungefähr 5 N bis 40 N liegt.

46. Verfahren nach Anspruch 31, bei dem der erste Satz Stemmfinger zwischen den kreisförmigen Umfangsflanschen jeder vorderen und hinteren Formhälfte der Kontaktlinsenform-Einrichtung eingebracht wird, während die hintere Formfläche mit einer vorbestimmten Dampfmenge beaufschlagt wird.

47. Dampfdüsenvorrichtung (6) zum Erwärmen einer hinteren Formhälfte (19) einer Kontaktlinsenform-Einrichtung (11), die eine zwischen einer vorderen Wölbungshälfte (17) und einer hinteren Wölbungshälfte (19) geformte Kontaktlinse (12) umfaßt, wobei die Düsenvorrichtung (60) aufweist:

(a) mehrere Dampfdüsen (60), um auf mehrere Kontaktlinsenform-Einrichtungen (11) einzuwirken, wobei jede Düse (60) umfaßt:

(i) eine Einrichtung (63) zum Abdichten der Düse (60) an der Formeinrichtung (11), um eine Wärmkammer zwischen der Düse und der Kontaktlinsenform-Einrichtung (11) zu schaffen;
(ii) eine Dampföffnung (42) zum Abgeben von Dampf in die Wärmkammer; und
(iii) zumindest eine Öffnung (44), die in jeder Düse (60) zum Ausströmen von Dampf aus der Wärmkammer definiert ist;

(b) eine Einrichtung (72) zum Bewegen der Dampfdüsen (60) in Eingriff mit den Kontaktlinsenform-Einrichtungen (11);
(c) einen ersten Kanal zum Verteilen von Dampf an jede Düseneinrichtung; und
(d) einen zweiten Kanal, um ein Vakuum durch die Auslaßöffnungen hindurch anzulegen, damit Dampf aus der Wärmkammer ausströmt, wodurch ein Temperaturgradient zwischen der hinteren gewölbten Formhälfte und der Kontaktlinse in der Formeinrichtung erzeugt werden kann.

48. Dampfdüsenvorrichtung nach Anspruch 47, die eine Einrichtung (130) zum Versorgen der Wärmkammer mit einer vorbestimmten Dampfmenge umfaßt.

49. Dampfdüsenvorrichtung nach Anspruch 47, bei der die Einrichtung zum Bewegen der Dampfdüsen in Eingriff mit der Kontaktlinsenform-Einrichtung eine Einrichtung zum Vorbewegen der Düsen in unmittelbare Nähe einer Fläche der hinteren Formhälfte, bevor Dampf abgegeben wird, und zum Zurückbewegen der Düseneinrichtung von der hinteren Formfläche weg umfaßt, nachdem der Dampf auf die hintere Formfläche aufgetroffen ist.

50. Dampfdüsenvorrichtung nach Anspruch 47, bei der die Einrichtung zum Dichten der Düse an der Formeinrichtung eine Einrichtung zum Erzeugen einer dauerhaften luftdichten Dichtung zwischen dem Düsenkopf und der hinteren Formfläche umfaßt, bevor Dampf auf die hintere Formfläche auftreffen wird.

51. Dampfdüsenvorrichtung nach Anspruch 50, bei der die Einrichtung zum Erzeugen einer dauerhafte Dichtung eine O-Ringdichtung ist, die am Umfang des Düsenkopfs ausgebildet ist.

52. Dampfdüsenvorrichtung nach Anspruch 47, die eine Heizeinrichtung (153a, b) umfaßt, um jegliches Kondensat zu verdampfen, das sich an einer Fläche innerhalb der Düseneinrichtung bilden kann.

53. Dampfdüsenvorrichtung nach Anspruch 52, bei der die Heizeinrichtung Heizpatronen umfaßt, die an vorbestimmten Stellen in der Düseneinrichtung angeordnet sind.

54. Dampfdüsenvorrichtung nach Anspruch 47, die mehrere Ausströmöffnungen (44a, b) umfaßt, welche die Dampföffnung umgeben.

55. Dampfdüsenvorrichtung nach Anspruch 48, die eine Steuereinrichtung und ein Ventil für die Versorgung mit einer vorbestimmten Dampfmenge umfaßt.

Revendications

1. Appareil (10) pour séparer des ensembles formant moule pour lentilles de contact individuels (100a, 100b), chacun desdits ensembles ayant un moule pour lentille de contact (25) entre une moitié de moule avant (17) et une moitié de moule arrière (19), chacune desdites moitiés de moule ayant des brides circonférentielles annulaires (26, 27), ledit appareil comprenant des moyens pour démouler, lesdits moyens comprenant des moyens levier (110a, b) devant être insérés entre lesdites brides circonférentielles annulaires (26, 27) de chacune desdites moitiés de moule avant et de moule arrière (17, 19) dudit ensemble formant moule pour lentilles de contact (11), lesdits moyens levier comprenant un premier jeu de doigts leviers (115) et un deuxième jeu de doigts leviers (116), et ;

   des premiers moyens (65a, b) pour appliquer de la vapeur à une première température sur ladite moitié de moule arrière pour former un gradient de température allant de 2,5°C à 6,0°C entre ladite moitié de moule arrière (19) et ladite moitié de moule avant (17) ;

   dans lequel ledit premier jeu de doigts leviers (115) desdits moyens de démoulage est pour retenir ladite moitié de moule avant (17), et ledit deuxième jeu de doigts leviers (116) desdits moyens de démoulage est pour dévier ladite moitié de moule arrière (19) vers le haut à une force prédéterminée par rapport à ladite moitié de moule avant (17) pour en retirer de manière efficace ladite moitié de moule arrière (19).

2. Appareil pour séparer des ensembles formant moule selon la revendication 1 comprenant en outre des moyens de saisie sous vide (85) associés à l'un desdits ensembles formant moule pour lentilles de contact, dans lequel lesdits moyens de saisie sous vide (85) saisissent simultanément ladite moitié de moule arrière alors que ladite moitié de moule arrière est retirée de sa moitié de moule avant respective.

3. Appareil pour séparer des ensembles formant moule selon la revendication 1 dans lequel lesdits moyens levier comprennent des moyens pour déplacer ledit premier jeu de doigts leviers dans une direction sensiblement verticale pour lever ladite bride circonférentielle circulaire sur les côtés de chacune desdites moitiés de moule arrière et pour retirer chacune desdites moitiés de moule arrière des moitiés de moule avant respectives.

4. Appareil pour séparer des ensembles formant moule selon la revendication 3 dans lequel ledit deuxième jeu de doigts leviers est positionné pour ancrer lesdites moitiés de moule avant alors que ledit premier jeu de doigts leviers dévie lesdites moitiés de moule arrière vers le haut.

5. Appareil pour séparer des ensembles formant moule selon la revendication 4 dans lequel chaque premier et deuxième jeu de doigts leviers est extensible depuis une première position rétractée vers une deuxième position étendue entre lesdits bords circonférentiels circulaires de chacune desdites moitiés de moule arrière et de moule avant dudit ensemble formant moule pour lentilles de contact.

6. Appareil pour séparer des ensembles formant moule selon la revendication 1 dans lequel lesdits premiers moyens pour appliquer de la vapeur comprennent des moyens pour appliquer (130) une quantité prédéterminée de vapeur.

7. Appareil pour séparer des ensembles formant moule selon la revendication 6 dans lequel lesdits premiers moyens pour appliquer de la vapeur comprennent des moyens pour décharger de la vapeur à travers une buse (60) associée à un ensemble formant moule pour lentilles de contact.

8. Appareil pour séparer des ensembles formant moule selon la revendication 6 comprenant un outre des moyens palette (21) pour transporter une pluralité d'ensembles formant moule pour lentilles de contact dedans, lesdits moyens palette étant positionnés à proximité desdits moyens d'application de la vapeur avant que ladite vapeur ne soit déchargée sur les surfaces de moule courbes arrière.

9. Appareil pour séparer des ensembles formant moule selon la revendication 8 dans lequel lesdits premiers moyens comprennent en outre des moyens pour faire avancer (72) lesdits moyens de décharge de la vapeur depuis une première position jusqu'à une deuxième position au niveau de ladite palette positionnée avant de décharger de la vapeur sur chacune desdites surfaces de moule arrière, et pour faire reculer lesdits moyens d'application de la vapeur depuis ladite palette positionnée vers ladite première position après avoir déchargé la vapeur au niveau de chacune desdites surfaces de moule arrière.

10. Appareil pour séparer des ensembles formant moule selon la revendication 9 comprenant en outre des moyens de saisie (85) associés à un desdits ensembles formant moule pour lentilles de contact pour saisir ladite moitié de moule arrière lorsque ladite moitié de moule arrière est séparée de sa moitié de moule avant respective.

11. Appareil pour séparer des ensembles formant moule selon la revendication 10 comprenant en outre des moyens pour étendre lesdits moyens de saisie vers ladite palette après que lesdits moyens de décharge de vapeur se sont rétractés loin de ladite palette.

12. Appareil pour séparer des ensembles formant moule selon la revendication 10 comprenant en outre des moyens pour générer un vide pour lesdits moyens de saisie pour permettre auxdits moyens de saisie de saisir une surface de moule courbe arrière respective après l'application de vapeur dessus.

13. Appareil pour séparer des ensembles formant moule selon la revendication 11 dans lequel lesdits moyens pour étendre lesdits moyens de saisie rétractent davantage lesdits moyens de saisie vers une position rétractée alors que lesdits moyens de saisie saisissent une partie de moule arrière individuel séparée.

14. Appareil pour séparer des ensembles formant moule selon la revendication 13 dans lequel lesdits moyens pour générer un vide comprennent en outre des moyens pour briser ledit vide pour décharger lesdites parties de moule arrière depuis leurs moyens de saisie associés au niveau de ladite position rétractée.

15. Appareil pour séparer des ensembles formant moule selon la revendication 1 dans lequel ledit premier jeu de doigts leviers est un jeu contigu de jambes en forme de U (112) qui ont sensiblement une forme pour s'insérer entre lesdites brides circonférentielles circulaires de chacune desdites moitiés de moule arrière et de moule avant.

16. Appareil pour séparer des ensembles formant moule selon la revendication 15 dans lequel ledit deuxième jeu de doigts leviers est un jeu contigu de jambes en forme de U (114) qui ont sensiblement une forme semblable auxdites moitiés de moule et s'insèrent entre lesdites brides circonférentielles circulaires de chacune desdites moitiés de moule arrière et de moule avant pour ancrer efficacement chacune desdites moitiés de moule avant alors que ledit premier jeu de doigts leviers dévie lesdites moitiés de moule arrière vers le haut à des fins de retrait.

17. Appareil (10) pour séparer une moitié de moule arrière (19) d'une moitié de moule avant (17) d'un ensemble formant moule pour lentilles de contact (11) utile dans la production d'une lentille de contact (12), chacune desdites moitiés de moule avant et arrière (17, 19) ayant une section courbe centrale définissant une surface concave, une surface convexe, et un bord circonférentiel circulaire (26, 27), au moins une partie d'au moins une de ladite surface concave et de ladite surface convexe ayant les dimensions de la courbe avant ou arrière, respectivement, d'une lentille de contact (12) devant être produite dans ledit ensemble formant moule (11), ledit appareil comprenant des moyens levier (100a, b) devant être insérés entre lesdits bords circonférentiels circulaires (26, 27) de chacune desdites moitiés de moule arrière et de moule avant (17, 19) dudit ensemble formant moule pour lentilles de contact (11), lesdits moyens levier (100a, b) comprenant un premier et un deuxième jeux de doigts leviers (115, 116), et ;

des moyens pour appliquer de la vapeur (65a, b) sur ladite surface concave (18) de ladite moitié de moule arrière (19) tout en maintenant ladite surface convexe de ladite moitié de moule avant à une première température pour former un gradient de température allant de 2,5°C à 6,0°C entre ladite surface convexe (18) de ladite moitié de moule arrière (19) et ladite surface concave de ladite moitié de moule avant (17), et, en conséquence, un gradient de température sur ladite lentille de contact (12); et

dans lequel lesdits premier et deuxième jeux de doigts leviers (115, 116) desdits moyens levier (100a, b) sont pour dévier ladite moitié de moule arrière (19) vers le haut à une force prédéterminée par rapport à ladite moitié de moule avant (17) pour en retirer de manière efficace ladite moitié de moule arrière (19).

18. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 17 comprenant en outre des moyens de saisie (85) associés à l'un desdits ensembles formant moule pour lentilles de contact, dans lequel lesdits moyens de saisie saisissent simultanément une moitié de moule arrière alors que ladite moitié de moule arrière est retirée de sa moitié de moule avant respective.

19. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 17 dans lequel lesdits moyens levier comprennent des moyens pour déplacer ledit premier jeu de doigts leviers dans une direction sensiblement verticale pour lever ladite bride circonférentielle circulaire de chacune desdites moitiés de moule arrière et pour retirer chacune desdites moitiés de moule arrière des moitiés de moule avant respectives.

20. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 19 dans lequel ledit deuxième jeu de doigts leviers est inséré entre

lesdites brides circonférentielles circulaires de chacune desdites moitiés de moule arrière et de moule avant dudit ensemble formant moule pour lentilles de contact et positionné pour ancrer lesdites moitiés de moule avant alors que ledit premier jeu de doigts leviers dévie lesdites moitiés de moule arrière vers le haut.

21. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 20 dans lequel lesdits premier et deuxième jeux de doigts leviers sont extensibles depuis une première position rétractée vers une deuxième position étendue entre lesdites brides circonférentielles circulaires de chacune desdites moitiés de moule arrière et de moule avant dudit ensemble formant moule pour lentilles de contact.

22. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 17 dans lequel lesdits moyens pour appliquer de la vapeur sur ladite surface concave de ladite moitié de moule arrière comprennent des moyens buse (60) pour décharger la vapeur à des fins d'impact sur une surface de ladite moitié de moule arrière, lesdits moyens buse comprenant un corps de buse relié à une source d'alimentation en vapeur (130) et une tête de buse (61) ayant un orifice de décharge de vapeur (42).

23. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 22 dans lequel lesdits moyens pour appliquer de la vapeur sur ladite surface concave de ladite moitié de moule arrière comprennent des moyens pour évacuer simultanément la vapeur (44a, b) pour empêcher l'application d'une pression de vapeur excessive sur ladite moitié de moule arrière.

24. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 22 dans lequel lesdits moyens buse comprennent un ou plusieurs orifices d'évent reliés à une source de vide pour ventiler simultanément la vapeur de ladite surface de moule pendant l'impact de la vapeur dessus.

25. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 22 dans lequel lesdits moyens pour appliquer de la vapeur sur ladite surface concave de ladite moitié de moule arrière comprennent en outre des moyens (72) pour positionner lesdits moyens buse à proximité étroite d'une surface de ladite moitié de moule arrière avant la décharge de la vapeur et pour rétracter lesdits moyens buse loin de ladite surface de moule arrière après l'impact de la vapeur dessus.

26. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 17 dans lequel lesdits moyens pour appliquer de la vapeur sur ladite surface concave de ladite moitié de moule arrière comprennent des moyens buse pour décharger la vapeur à des fins d'impact sur une surface de ladite moitié de moule arrière, lesdits moyens buse comprenant un corps de buse relié à une source d'alimentation en vapeur et une tête de buse ayant un orifice à vapeur, lesdits moyens buse comprenant en outre des moyens pour créer un joint sensiblement étanche entre ladite tête de buse et ladite surface de moule arrière avant l'impact de la vapeur dessus.

27. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 26 dans lequel lesdits moyens pour créer un joint sensible sont un joint torique formé autour d'une périphérie de ladite tête de buse.

28. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 27 dans lequel ledit joint torique est fait d'EDPM.

29. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 22 dans lequel lesdits moyens pour appliquer de la vapeur sur ladite surface concave de ladite moitié de moule arrière comprennent en outre des moyens chauffants pour vaporiser toute condensation existante qui peut se former sur une surface à l'intérieur dudit corps de buse.

30. Appareil pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 29 dans lequel lesdits moyens chauffants comprennent des dispositifs chauffants à cartouche situés à des endroits prédéterminés dans lesdits moyens buse.

31. Procédé pour séparer une moitié de moule arrière (19) d'une moitié de moule avant (17) d'un ensemble formant

moule pour lentilles de contact (11) utile dans la production d'une lentille de contact (12), chacune desdites moitiés de moule avant et arrière (17, 19) ayant une section courbe centrale définissant une surface concave, une surface convexe, et une bride circonférentielle circulaire, au moins une partie d'au moins une de ladite surface concave et de ladite surface convexe ayant les dimensions de la courbe avant ou arrière, respectivement, d'une lentille de contact (12) devant être produite dans ledit ensemble formant moule (11), ledit procédé comprenant les étapes consistant à :

(a) insérer un premier jeu de doigts leviers (115) entre lesdites brides circonférentielles circulaires (26, 27) de chacune desdites moitiés de moule avant (17) et de moule arrière (19) dudit ensemble formant moule pour lentilles de contact (11) ;
(b) appliquer une quantité prédéterminée de vapeur sur ladite surface de moule pour lentilles courbe arrière pour former un gradient de température entre ladite moitié de moule arrière et ladite moitié de moule avant ; et
(c) dévier ledit premier jeu de doigts leviers (115) dans une direction sensiblement verticale afin de retirer simultanément ladite moitié de moule arrière (19) de sa moitié de moule avant (17) associée ;

dans lequel le gradient de température va de 2,5°C à 6,0°C.

32. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 31 comprenant l'étape consistant à créer un joint sensiblement étanche entre ladite surface de moule arrière et des premiers moyens buse pour décharger la vapeur à des fins d'impact sur une surface de ladite moitié de moule arrière, lesdits moyens buse comprenant un corps de buse relié à une source d'alimentation en vapeur, une tête de buse ayant un orifice de décharge de vapeur et des moyens pour créer un joint sensiblement étanche entre ladite tête de buse et ladite surface de moule arrière.

33. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 31 comprenant en outre l'étape consistant à saisir ladite surface de moule arrière avec des moyens de saisie (85) avant de retirer ladite moitié de moule arrière de sa moitié de moule avant associée.

34. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 33 comprenant en outre l'étape (e) constant à rétracter ledit premier jeu de doigts leviers alors que lesdits moyens de saisie retiennent chaque moitié de moule arrière pour leur élimination.

35. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 31 dans lequel l'étape (d) consistant à dévier ledit premier jeu de doigts leviers dans une direction sensiblement verticale, comprend l'étape consistant à ancrer simultanément chacune desdites moitiés de moule avant pour empêcher leur levage.

36. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 31 dans lequel l'étape (b) consistant à appliquer une quantité prédéterminée de vapeur sur ladite surface de moule arrière comprend en outre l'étape consistant à ventiler simultanément la vapeur pour ainsi réguler la quantité de vapeur appliquée sur ladite surface de moule arrière.

37. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 36 dans lequel l'étape (b) consistant à appliquer une quantité prédéterminée de vapeur sur ladite surface de moule arrière comprend en outre l'étape consistant à créer un gradient de température sur lesdites moitiés avant et arrière.

38. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 37 dans lequel l'étape consistant à créer le gradient de température comprend en outre l'étape consistant à maintenir ladite moitié de moule avant à une température allant de 30°C à 85°C tout en appliquant de la vapeur à ladite moitié de moule arrière.

39. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 31 dans lequel avant l'étape (a), ledit procédé comprend en outre l'étape consistant à positionner une palette (21) contenant un ou plusieurs desdits ensembles formant moule pour lentilles de contact à côté de moyens d'application de vapeur (65a, b) ayant une pluralité de buses de décharge de vapeur (60), dans lequel chacune desdites courbes arrière est positionnée par rapport à une buse de décharge de vapeur

respective (60).

40. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 31 dans lequel la température de ladite vapeur appliquée sur la dite surface de moule arrière va de 100°C à 130°C.

41. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 40, dans lequel ladite surface convexe de ladite moitié de moule avant est maintenue à une température allant de 30°C à 85°C alors que ladite vapeur est appliquée sur ladite surface de moule arrière.

42. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 31, dans lequel la déviation dudit premier jeu de doigts leviers dans une direction sensiblement verticale de manière à retirer simultanément ladite moitié de moule arrière de sa moitié de moule avant associée survient à un moment prédéterminé après l'application de ladite vapeur.

43. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 42, dans lequel ledit moment prédéterminé va de 1,0 à 5,0 secondes.

44. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 42, dans lequel ledit moment prédéterminé est d'environ 1,5 seconde.

45. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 31 dans lequel ledit premier jeu de doigts leviers est dévié dans une direction sensiblement verticale de manière à retirer simultanément ladite moitié de moule arrière de sa moitié de moule avant associée à une force constante prédéterminée allant d'environ 5 N à 40 N.

46. Procédé pour séparer une moitié de moule arrière d'une moitié de moule avant d'un ensemble formant moule pour lentilles de contact selon la revendication 31 dans lequel ledit premier jeu de doigts leviers est inséré entre lesdites brides circonférentielles circulaires de chacune desdites moitiés de moule arrière et de moule avant dudit ensemble formant moule pour lentilles de contact alors qu'une quantité prédéterminée de vapeur est appliquée sur ladite surface de moule arrière.

47. Ensemble formant buse à vapeur (60) pour chauffer une moitié de moule arrière (19) d'un ensemble formant moule pour lentilles de contact (11), dans lequel ledit ensemble (11) comprend une lentille de contact (12) moulée entre une moitié courbe avant (17) et une moitié courbe arrière (19), ledit ensemble formant buse (60) comprenant :

(a) une pluralité de buses à vapeur (60) pour venir en prise avec une pluralité d'ensembles formant moule pour lentilles de contact (11), chacune desdits buses (60) comprenant :

(i) des moyens pour sceller (63) ladite buse (60) sur ledit ensemble formant moule (11) pour créer une chambre chauffante entre ladite buse et ledit ensemble formant moule pour lentilles de contact (11) ;
(ii) un orifice à vapeur (42) pour décharger la vapeur dans ladite chambre chauffante ; et
(iii) au moins un orifice (44) défini dans chacune desdites buses (60) pour évacuer la vapeur de ladite chambre chauffante.

(b) des moyens pour déplacer (72) lesdites buses à vapeur (60) en prise avec lesdits ensembles formant moule pour lentilles de contact (11) ;
(c) un premier plénum pour distribuer la vapeur à chacun des ensembles formant buse ; et
(d) un deuxième plénum pour créer un vide à travers lesdits orifices d'évent pour évacuer la vapeur de ladite chambre chauffante moyennant quoi un gradient de température peut être créé entre ladite moitié de moule courbe arrière et la lentille de contact dans ledit ensemble formant moule.

48. Ensemble formant buse à vapeur selon la revendication 47, qui comprend en outre des moyens pour fournir (130) une quantité prédéterminée de vapeur à ladite chambre chauffante.

49. Ensemble formant buse à vapeur selon la revendication 47, dans lequel lesdits moyens pour déplacer lesdites buses à vapeur en prise avec lesdits ensembles formant moule pour lentilles de contact comprennent en outre

des moyens pour faire avancer lesdites buses à proximité étroite d'une surface de ladite moitié de moule arrière avant la décharge de la vapeur et la rétraction desdits moyens buse loin de ladite surface de moule arrière après l'impact de la vapeur dessus.

50. Ensemble formant buse à vapeur selon la revendication 47, dans lequel lesdits moyens pour placer ladite buse sur ledit ensemble formant moule comprennent en outre des moyens pour créer un joint sensiblement étanche entre ladite tête de buse et ladite surface de moule arrière avant l'impact de la vapeur dessus.

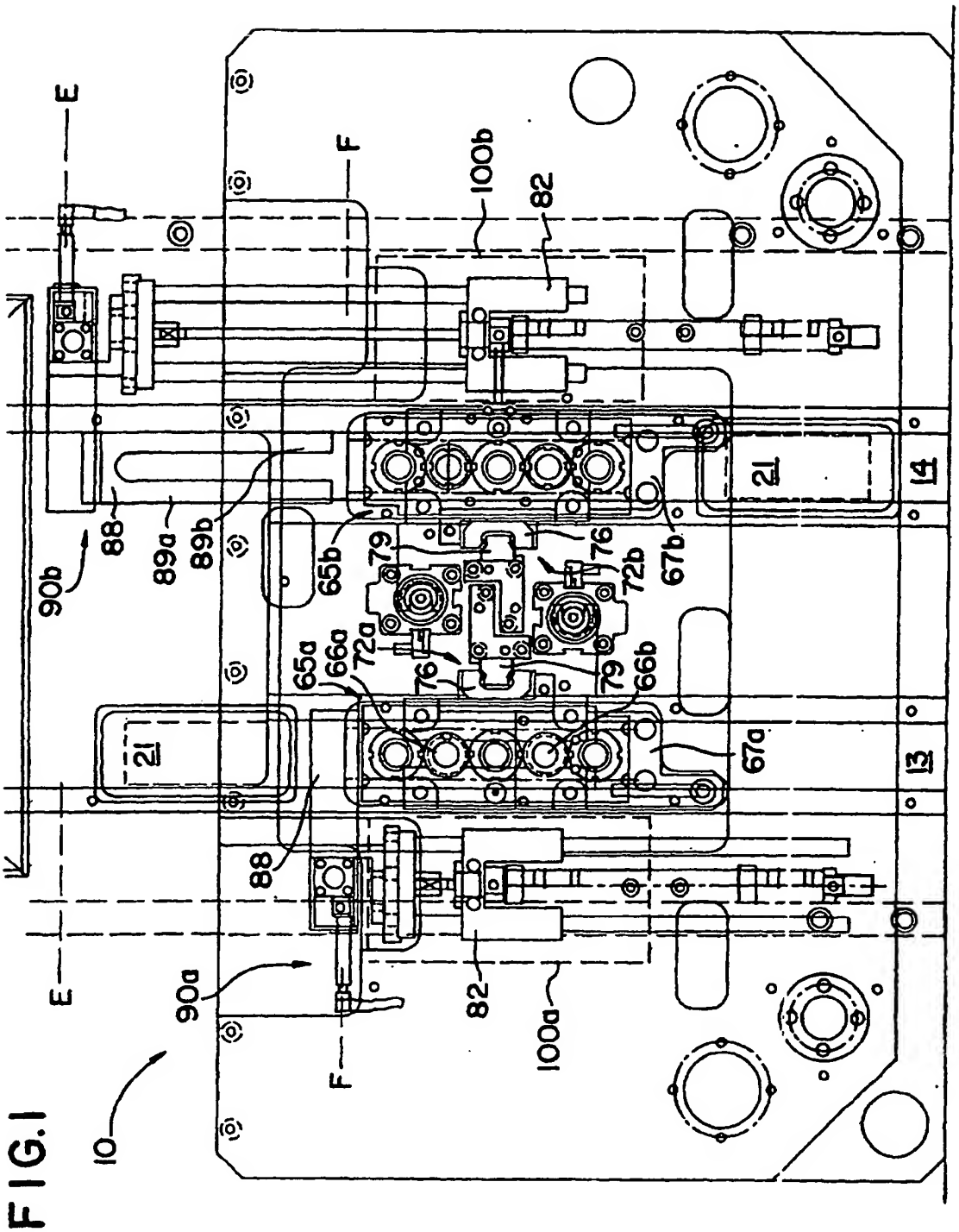
51. Ensemble formant buse à vapeur selon la revendication 50, dans lequel lesdits moyens pour créer un joint sensible est un joint torique formé autour d'une périphérie de ladite tête de buse.

52. Ensemble formant buse à vapeur selon la revendication 47 qui comprend en outre des moyens chauffants (153a, b) pour vaporiser toute condensation qui peut se former sur une surface à l'intérieur de l'ensemble formant buse.

53. Ensemble formant buse à vapeur selon la revendication 52 dans lequel lesdits moyens chauffants comprennent des dispositifs chauffants à cartouche situés à des endroits prédéterminés dans lesdits moyens buse.

54. Ensemble formant buse à vapeur selon la revendication 47 qui comprend en outre une pluralité d'orifices d'évent (44a, b) qui entourent ledit orifice à vapeur.

55. Ensemble formant buse à vapeur selon la revendication 48 qui comprend en outre des moyens de contrôle et des moyens soupape pour fournir ladite quantité prédéterminée de vapeur.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F
100b
82
21
14
88
89a
89b
65b
79
76
72b
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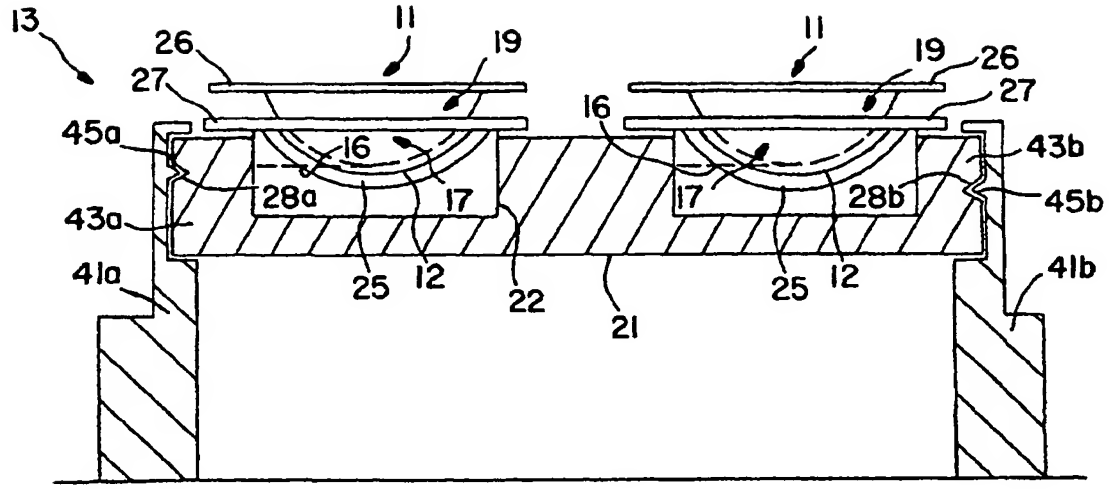
65a
66a
72a
66b
67a
13
90a
100a
10

FIG.1

FIG.2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19
27
16
45a
28a
17
43a
41a
25
12
22
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11
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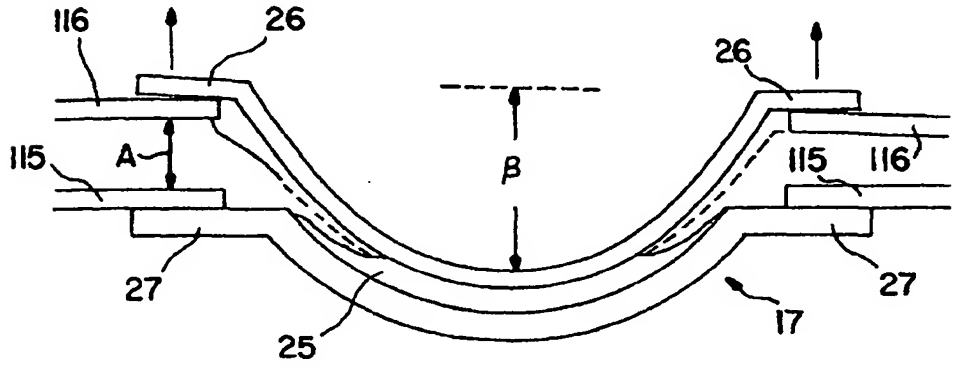
27
16
43b
17
28b
45b
25
12
41b

FIG.3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26
115
A
27
25
β
26
115
116
27
17

FIG. 4A

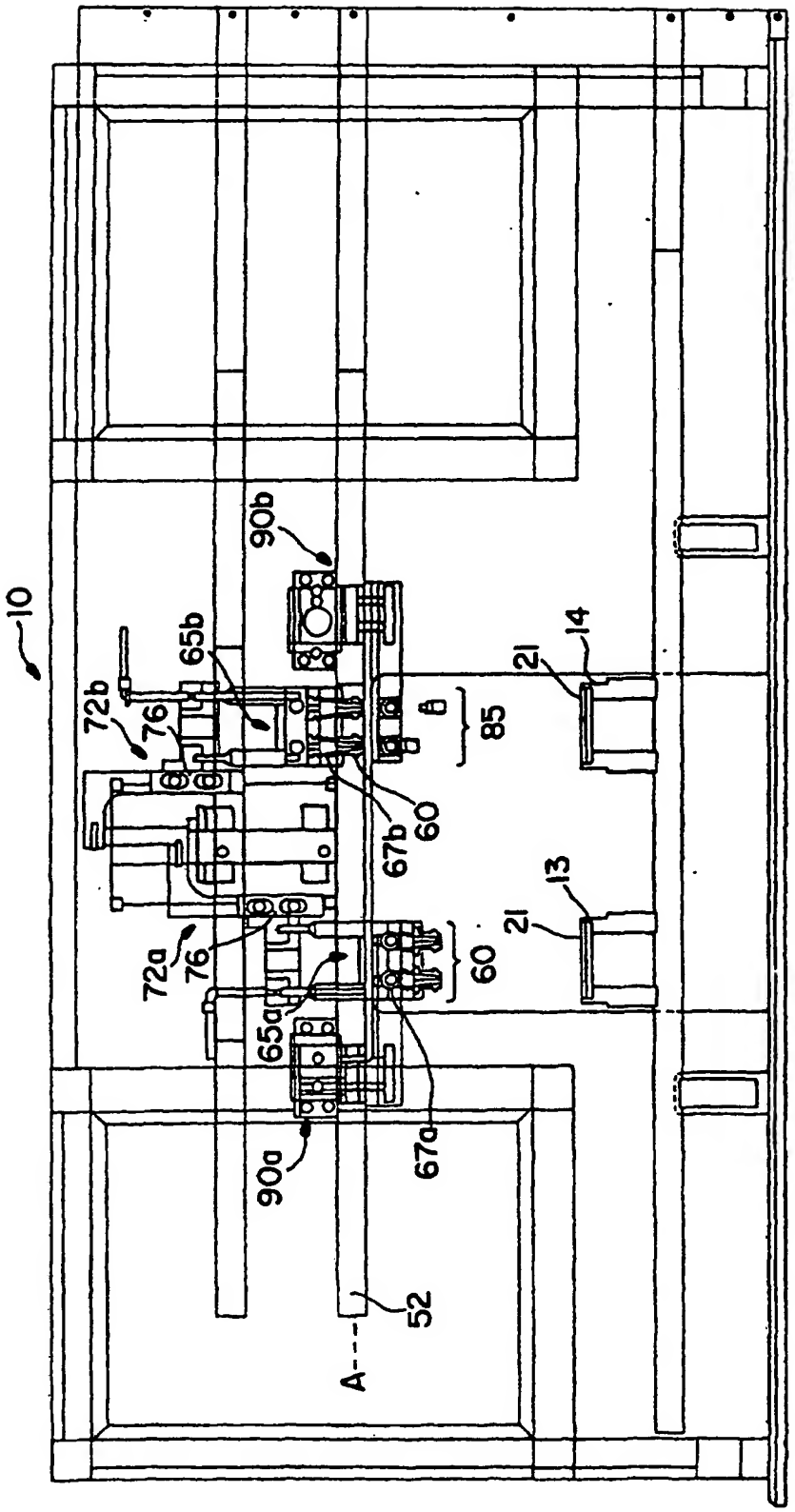


FIG.4B

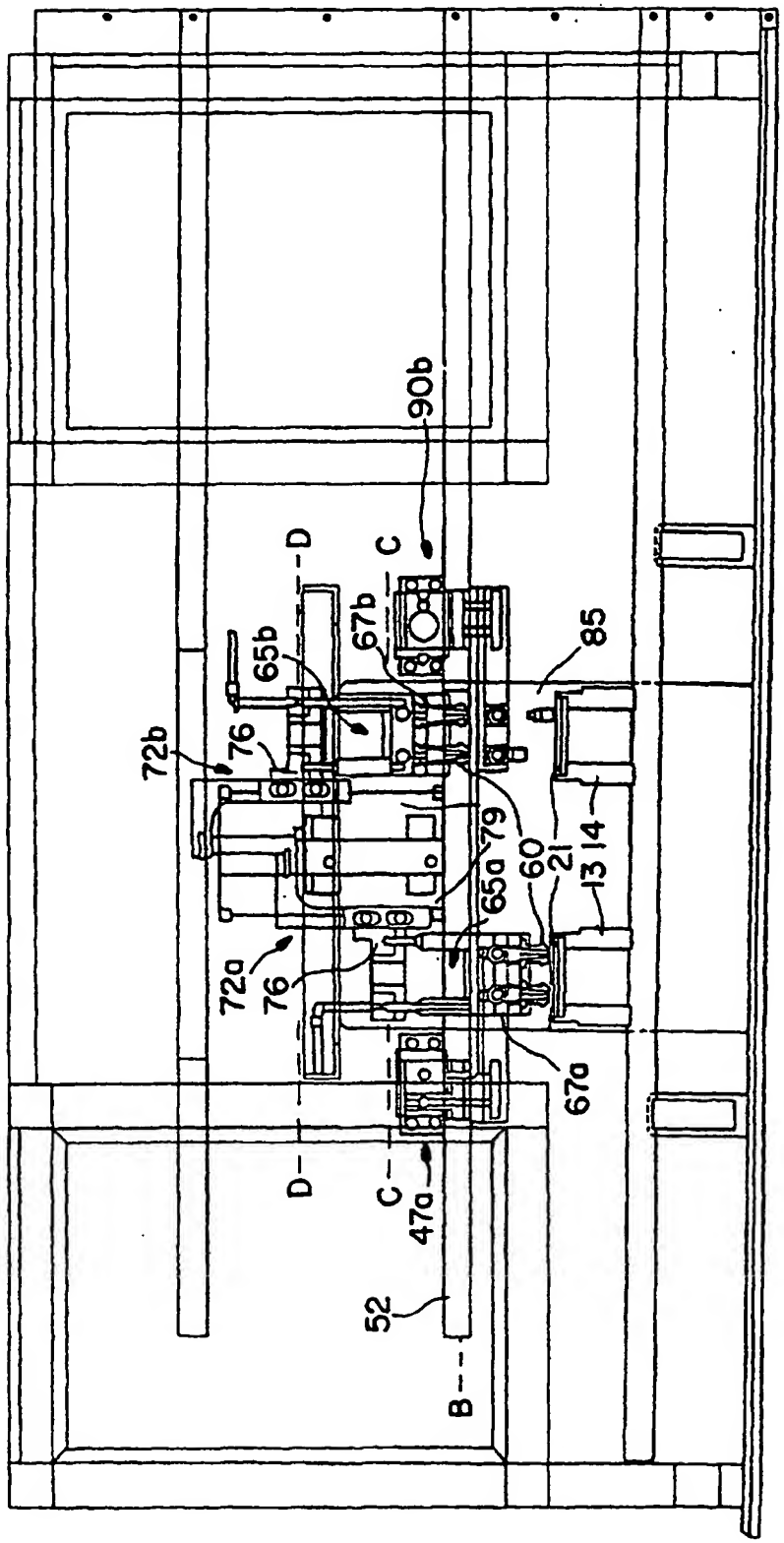


FIG.5

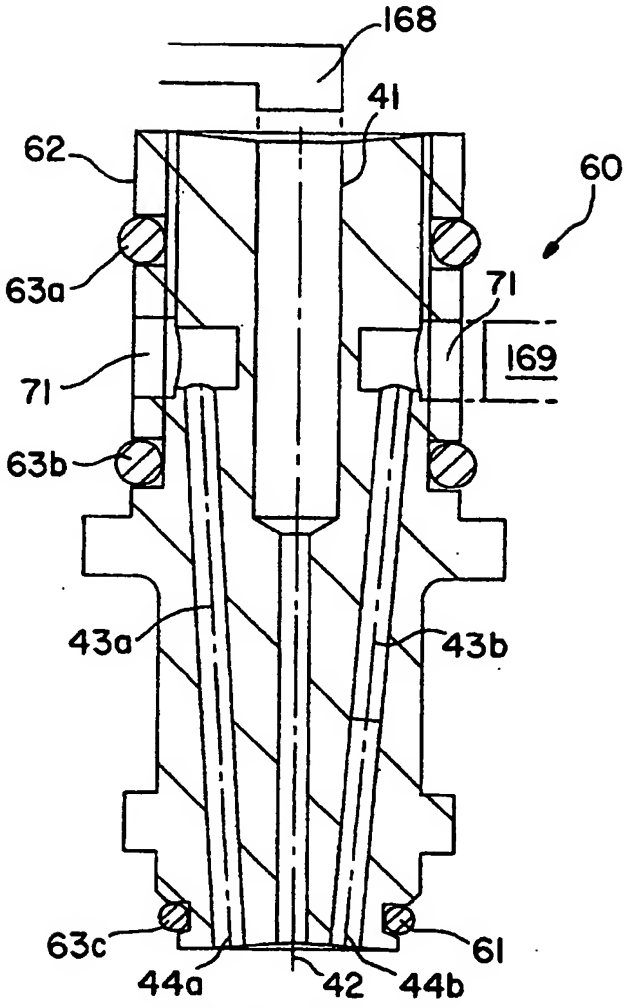
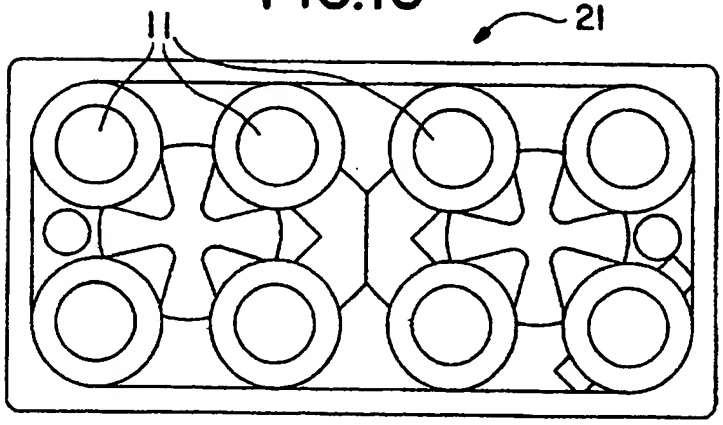


FIG.10



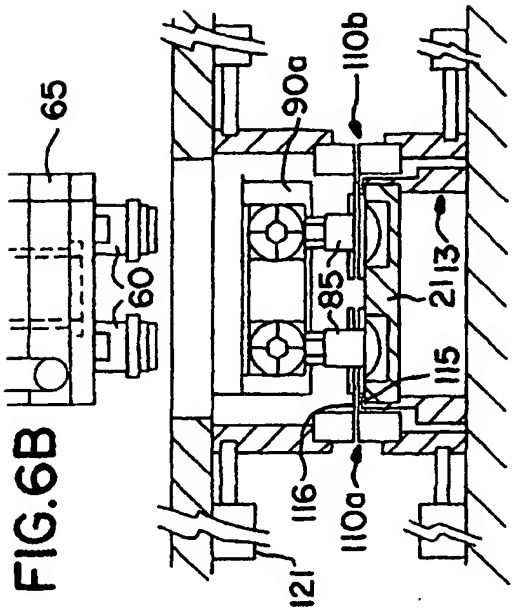


FIG.6B

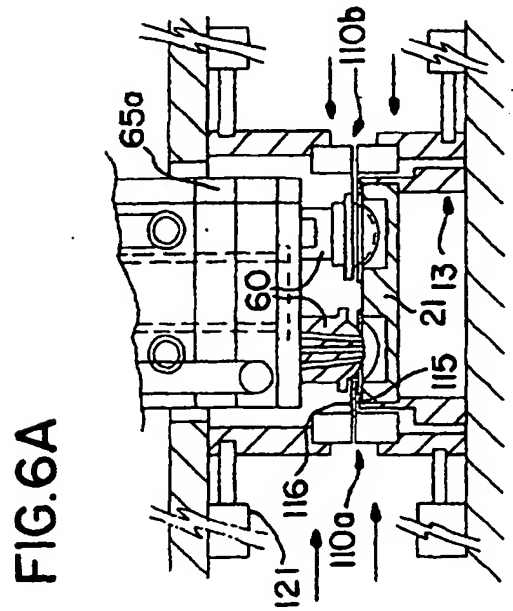


FIG.6A

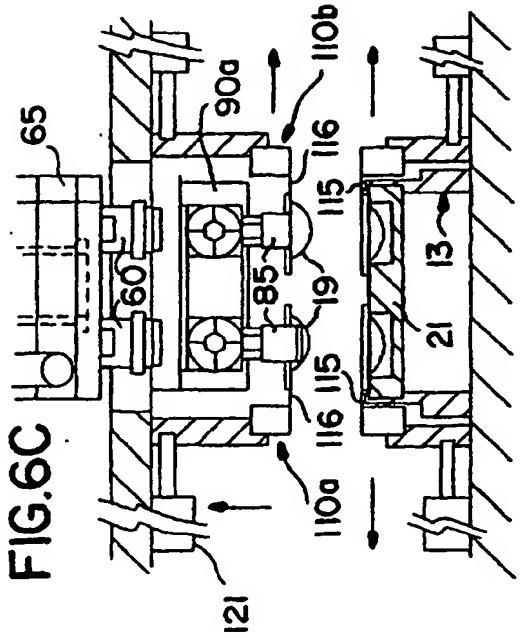


FIG.6C

FIG.6D

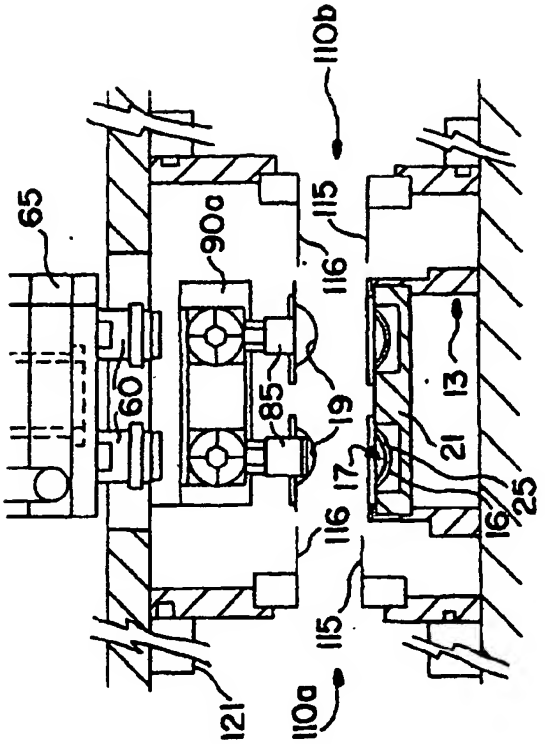

110b
65
90a
115
116
60
85
19
13
21
17
25
16
116
115
121
110a

FIG.7

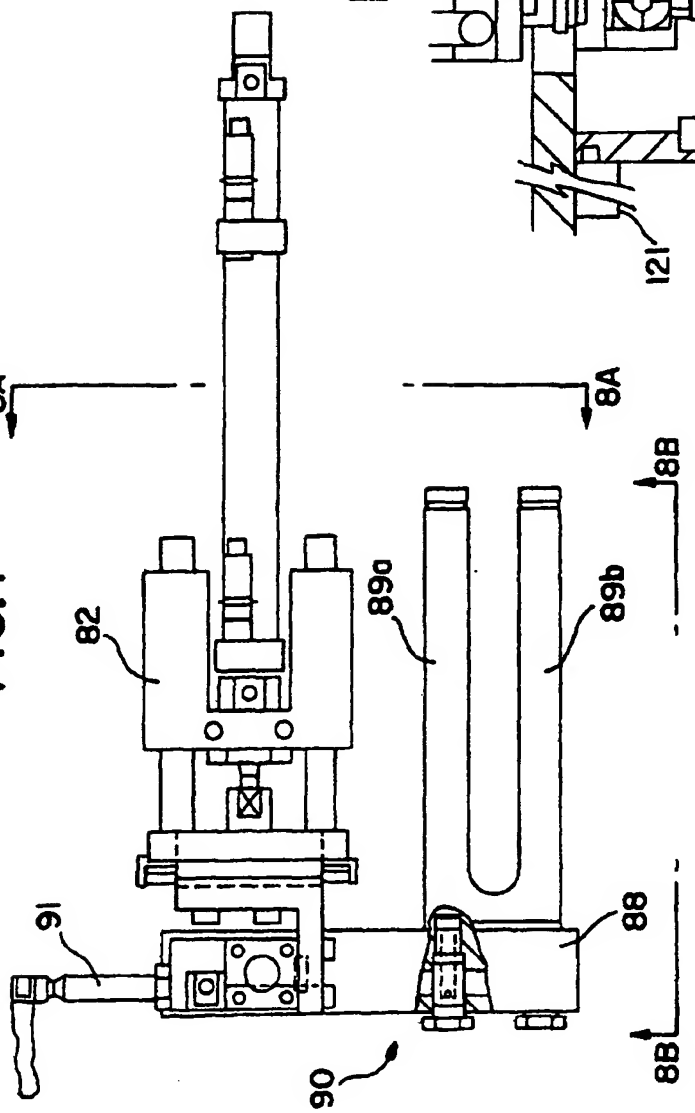

8A
8A
8B
82
89a
89b
91
88
90
8B

FIG.8A

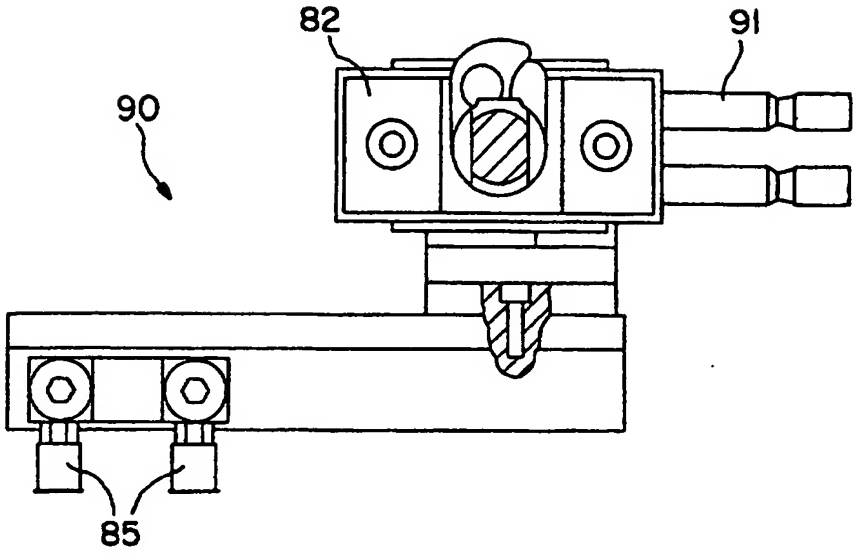
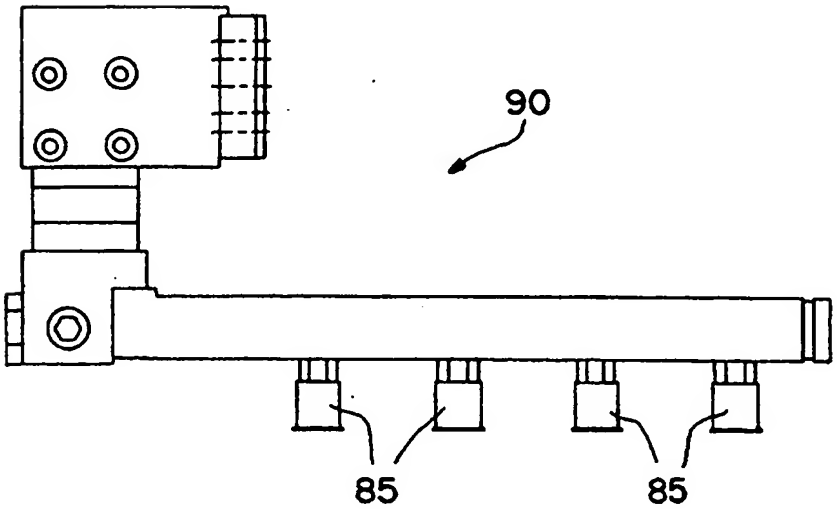


FIG.8B



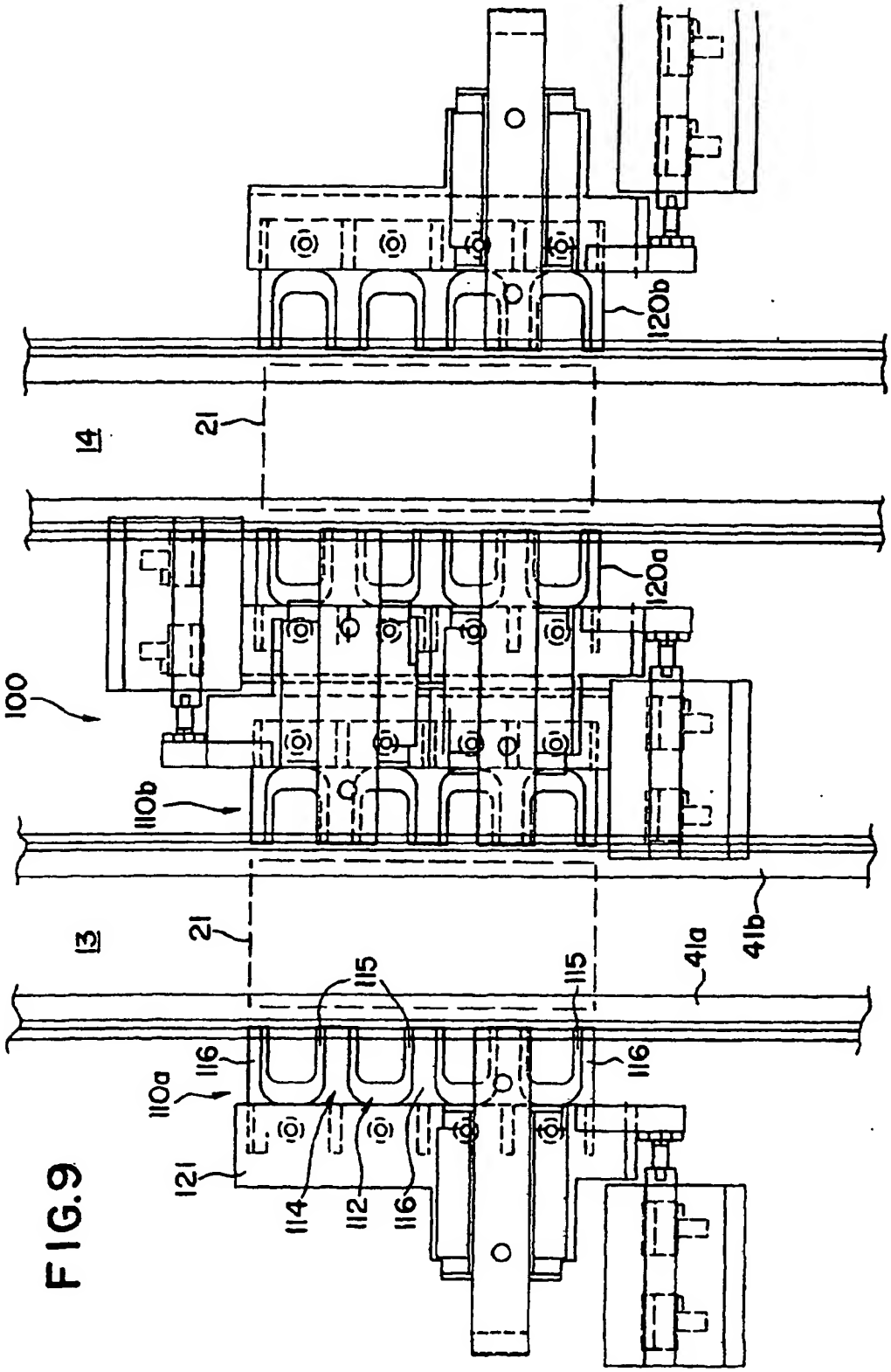

120b
14
21
120a
100
110b
13
21
41b
41a
115
115
116
116
110a
121
114
112
116

FIG.9

FIG.11

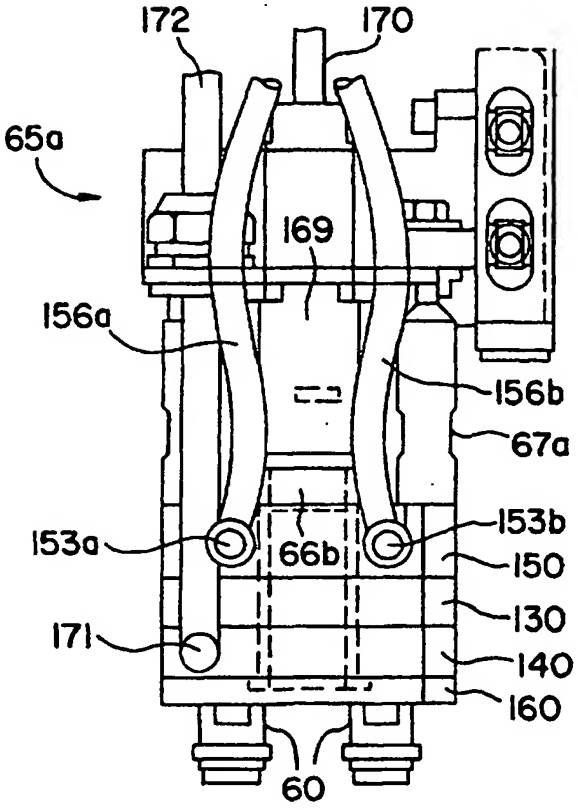


FIG.12C

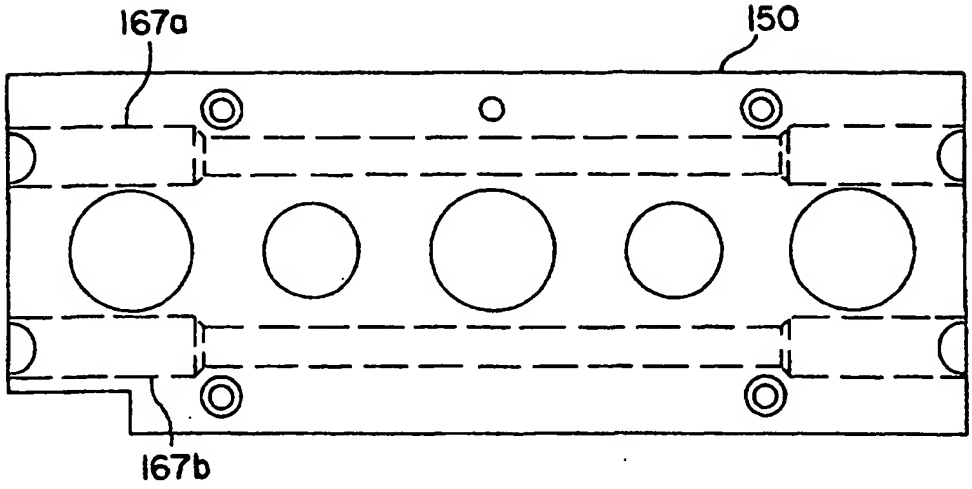


FIG.12A

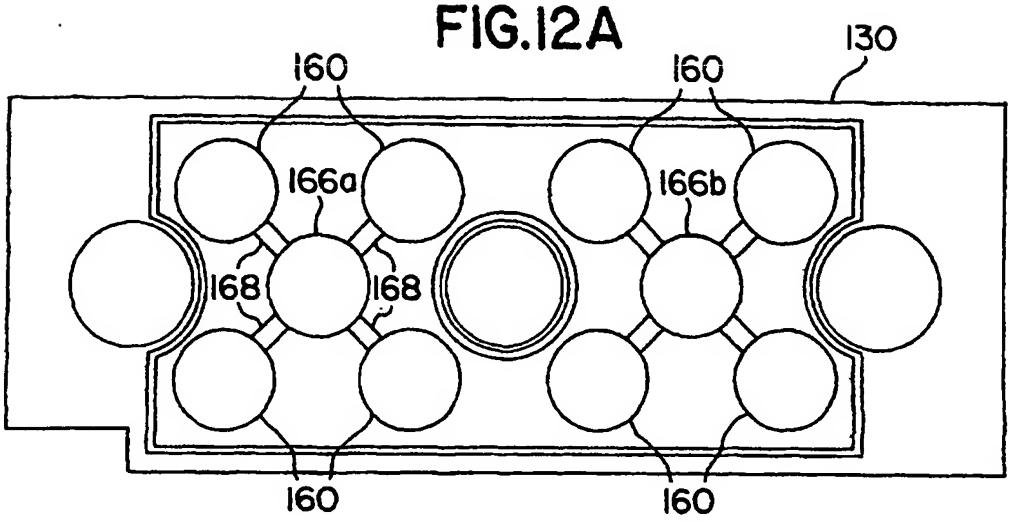


FIG.12B

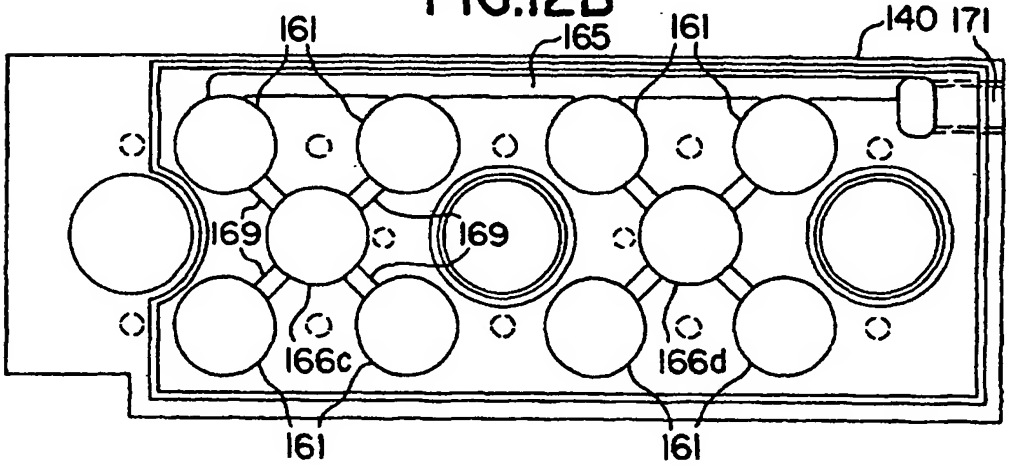


FIG.13